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Structures

Well-known cantilever bridge will be replaced after 40 years' service by two-hinged spandrel-braced arch of 640-ft. span, carrying a solid-floor deck of novel type—Advanced methods of design.

Long Span Steel Arch Bridge Over Niagara Gorge

Sanitation

Sewage disposal by dilution for Port of Portland afforded by slough enlarged by dike—Design — Construction — Channel flow.

Converting Columbia Slough into Sewage Outlets

Drainage

Levees and pumping plant with three types of motor-driven pumps—New sluice gate—Design — Assessment system.

Drainage Project on Columbia River at Portland

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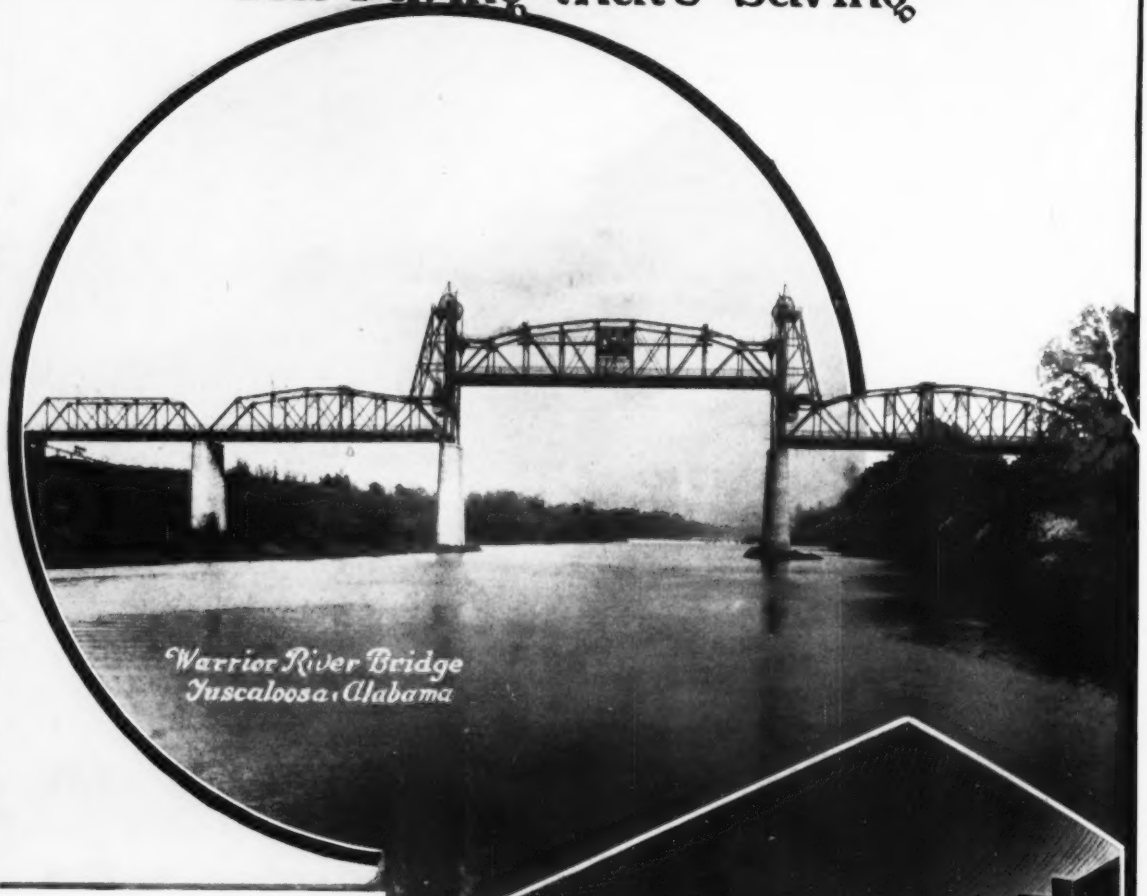

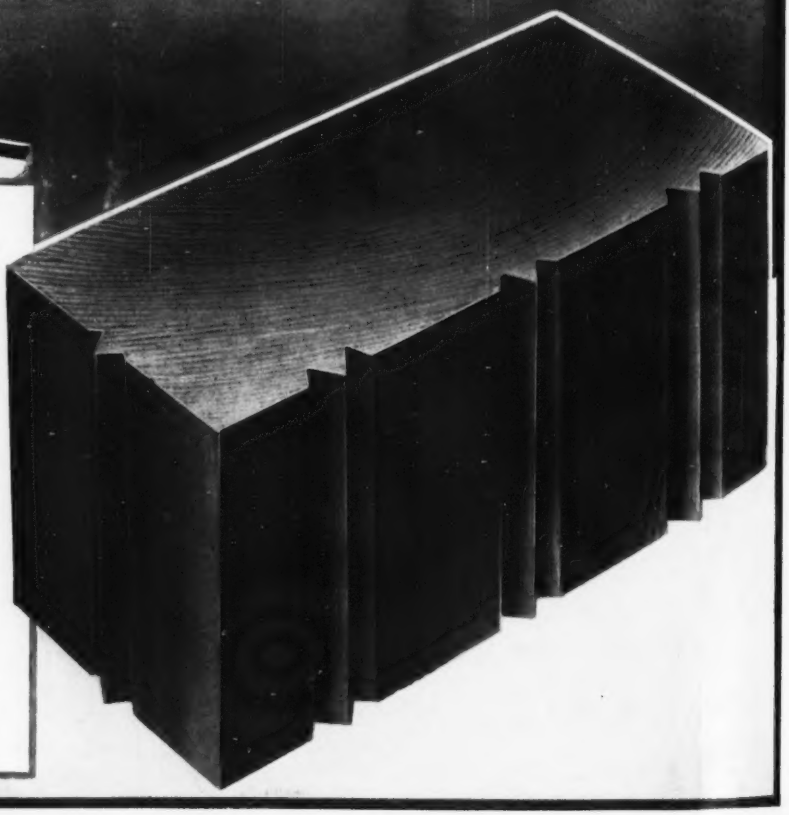

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 90 — NEW YORK, MARCH 1, 1923 — Number 9

Immigration Still a Problem

IN VIEW of the situation in the Senate no expectation survives that the present Congress will pass a new immigration law, and those industries which have been urging revision in order to insure an adequate supply of common labor must derive what consolation they can from the fact that they escaped the bill reported by the House committee. This provided clearly for further restriction rather than for a lowering of the bars. Meanwhile under the existing laws, the number of arrivals is higher than it was last year, but there is no expectation that these will meet the estimated requirements of industry. Although it appears, therefore, that we must make shift as best we can during the coming year, the need still is urgent for regulation that will provide at the same time for needful restrictions and an assured supply of selected immigrants qualified to meet our industrial needs. The new congress must tackle this whole problem anew in the light of the experience of the current year.

Bottle-Neck Street Intersections

LONG before the days of the ubiquitous automobile, traffic congestion at street intersections became a problem. Attempts at relief were made here and there by easing off corners and by traffic regulation. With the extension of automobile use in many parts of the country to what we may hope is nearly the saturation point, traffic congestion at thousands of points has become almost intolerable. More through-traffic streets are the most commonly urged relief measure but it is becoming more and more evident that street intersections are the bottle necks that retard traffic. Moreover, these bottle necks are by no means restricted to cities, as every one who uses the automobile for country travel well knows. From now on relief of traffic congestion at street intersections must have increasing attention. It will be necessary as a matter of traffic regulation and as an element in city replanning. It is imperative that it be given careful attention in all layouts of new streets. The basic facts for providing the remedy are set forth convincingly and in detail in Mr. Swan's article elsewhere in this issue. There may also be consulted with profit an article by Mr. Swan on the control of automobile speeds that appeared last week. Both articles are important contributions to the science and art of traffic regulation and of city planning.

Opposing Henry Ford

THE Ford offer for Muscle Shoals is dead for the present session of Congress, but it will be resurrected. When it is brought up at the next session it is to be hoped that its advocates will recognize the honesty of the real opposition to the proposal. In the South, particularly in the neighborhood of the plant itself, the feeling is intense that those opposed to Mr. Ford are urged by political or financial prejudices, in plain words that they are either Republicans or denizens of Wall Street. These enthusiasts might well take to heart Barrie's fine injunction in his address on "Courage"—"never impute to your adversary motives lower than you have yourself." Politics and finance play their part in the fight on the Ford plan but we believe the balance of the opposition is held by those who for years have been fighting for an equitable water-power policy and who see in Ford's Muscle Shoals offer a direct refutal of that policy made in the name of expediency by one of the most powerful individuals in the country. If there is to be one law for Henry Ford and another for the rest of us, we might as well make him dictator instead of president as his friends are urging. Only a few changes in the Ford proposal are needed to bring around to his side those whose opposition is based on principle. Will not Mr. Ford's advisers persuade him to volunteer those changes and thus make possible the useful development he has planned?

British Concrete Road Practice

PROTECTIVE bituminous covering for concrete roads have proved to be of such indifferent value in America that highway engineers here will regard with interest the statement in the article on British concrete road practice that some adhesive covering is held to be absolutely essential in England to make concrete roads a complete success. Incidentally none of the reasons given for bituminous covering would be considered in this country to be a justification for the extra cost and trouble of construction. One feature of the English construction which is to be remarked by those who have had trouble from "peeling" of the bituminous carpet is the care taken to prepare the surface of the concrete so as to insure adhesion. It exemplifies the obviously greater care and deliberation which the British road builder considers practicable to adopt in his concrete road building. Two other practices which stand out in the English work are the care taken in constructing the subgrade and the building of the slab in blocks laid alternately. Both entail an extra cost which American road officials would regard askance although the care in subgrade construction could well be taken as an example. This English road work is worth noting in another respect—provision is made for protecting the operations so that slab construction can proceed in wet weather.

Quantity Surveying

IN ENGLAND, as most of our readers know, the quantity survey system in bidding on construction is well established. All prospective bidders take the quantity figures computed by the surveyor as the basis for bids, which are made up in each case by extending those quantities against unit prices estimated by each bidder. In America the practice has never obtained a good foothold, although several attempts have been made to establish it. Individualism of the American contractor, probably, is the controlling cause; he is

reluctant to trust anyone outside his own organization on a matter so affecting his total bid. It is worth noting, though, that this reluctance is being overcome in one or two centers, notably in the middle northwest where, in Wisconsin and in Michigan, quantity survey bureaus have been operated with some success. It requires some time for any such bureau to breed confidence and to prove its economy to the individual contractor, but the system itself, if efficient, is a move toward a general economy in the business of construction and as such should be encouraged.

Italian Water-Works Enterprise

AS AN AQUEDUCT SYSTEM and in number of communities supplied the Apulian aqueduct with its branches feeding many score networks of street mains stands unequalled. The Coolgardie pipe line in Australia is far longer than the Apulian main trunk, but it is only a small steel force main supplying communities relatively few in number and small in total population. The Los Angeles aqueduct is considerably longer than the Apulian main trunk and much larger but it supplies fewer people, and these are mostly concentrated in one city. The Catskill aqueduct approaches in length the Apulian main trunk, has several times its carrying capacity, and supplies the American metropolis, but here again the enterprise is that of a single city. In number of places supplied from a single water-works system the Hackensack Water Co., in northeastern New Jersey, comes next to the Apulian enterprise, serving more than fifty separate municipalities with pumped and filtered water. Details of the Apulian system, with its 993 miles of main and branch aqueducts and subsidiary conduits, not counting the pipe distribution systems within its 266 communities, cannot fail to interest the entire water-works fraternity as well as all who watch the ambitious engineering projects being carried out in various parts of the world. The Apulian project does great credit alike to the engineers who conceived and executed it, the concessionaire who had the courage to undertake it and the Italian Government which took it over in 1919 and placed its administration in the charge of a board which includes representatives of the interested provinces. Apulia is to be congratulated on having provided for it a water supply which will doubtless restore some of its communities to the prosperity if not the glory of old. Portions of the district, if we mistake not, are the scene of the travels recorded in Gissing's charming "By the Ionian Sea," in the course of which stress is laid on the desolation caused by lack of water.

Crossing the Niagara

SINCE the earliest days, anything connected with crossing of the Niagara River has commanded universal interest. And from the time the first suspension bridge was begun all that has been done in bridging the gorge contributed notably to the advance of the bridge engineering art. The cantilever bridge which is shortly to pass out of existence was among these works of note, and in spite of the weaknesses which increasing knowledge and the test of service have brought to light, its long life—now nearly forty years—testifies to the excellence of the engineering skill embodied in it. Its successor, the 640-ft. arch to be built this year, carries fully as much interest as any of the other Niagara Gorge bridges, not only because of its great size but perhaps even more because of the remarkably thorough methods applied to its design. Its general form and dimensions being largely determined by the local topography, are probably not to be taken as representing the unhindered ideas of the engineers concerning ideal proportions for a heavy arch of six to seven hundred feet span. But aside from exterior outline the design is a model of excellence of practice, both in the proportioning of members and in the working out of details. The two outstanding points of note, perhaps, are the unusual floor construction and the high unit stresses applied to the dimensioning of the members. The floor is an important development in bridge construction; the separate superimposed floor structure on top of the main frame of the bridge may prove to have merits aside from the reasons which led to its being devised for this case. Further, it carries the use of heavy ballasted decks into the field of very long spans, establishing a new record in this respect. The high unit stresses used in the design similarly represent a reaching out toward a new standard of practice. But in considering these high figures it should be observed carefully that the stress computations took into account every effect of load and distortion that could be evaluated, including secondaries, torsion and the like. In other words, the engineers consciously endeavored to reduce the margin of unknown actions to a minimum, and thereby minimize the functions of the conventional "safety margin." The advance of modern structural engineering thought and practice is quite clearly in this direction; the engineers of the Michigan Central have given the movement a strong forward impetus by their work.

Solving the Truck Overload Problem

IF THE operation of motor vehicles and the construction and maintenance of roads were paid for out of the same purse it is probable that we should soon see the end of destructive truck loading. In railway operation this condition of a common pocketbook exists and therefore there has seldom been for any long period any great discrepancy between the strength of the road structure and the weights of the vehicles which travel over it. Railway roadbed and track and railway train loads are, generally speaking, reasonably well co-ordinated. This should be as true of highway transportation and for exactly the same reason. It is the peoples' money that operates the vehicle and provides the roadway on which it runs; the only difference from railway practice is that the money is handed out directly for vehicle operation and is paid through an agent—the public road official—for building and keeping up the road structure. It is this difference, however, which keeps the overloaded truck on the highway. The heavy truck operator, perhaps two per cent of all, is not so ingenuous that he does not realize that while he takes all the profit of overloading his neighbors help him to pay the damages to the road. The neighbors because they pay indirectly by means of taxes are not alert to the function imposed on them. Did they realize it the giant truck would soon be ruled off the public road. Highway departments have not been highly effective in their methods of carrying the lesson of truck overloads to the public.

One phase of the question in which there is room for reform is in the routing of heavy trucks. Arguing that the truck weighing 18 to 20 tons laden has an

economic place in highway transportation a class of truck builders and operators contend that it must be provided for and not abolished. It is again argued, in this case by shippers and manufacturers, that transportation emergencies arise not seldom when truck loads and speeds are superior to any hazard they bring to the highway. There is unquestioned truth in both arguments. In New England factory states instances are notable where, other transportation routes having been closed up, heavy and fast motor trucks traveling paved roads to their destruction have kept at work whole communities of people who otherwise would have been idle.

Where the traffic is constantly heavy enough to keep it busy, the 18 or 20-ton laden truck has an economic advantage over smaller trucks. To exclude it, then, from the service of transportation, demands justification. To permit it to be a free agent in choosing its own routes and speeds is impossible. The remaining resort is to restrict trucks of this class to specified lines of highway and, consequently, to build these roads to carry the loads. In isolated instances in several parts of the country such heavy truck roads have been built but in no case, we believe, is any one of them the result of a set policy to segregate by route heavy truck traffic from general traffic. Even in city street traffic, where the need is greater and the problem more simple, scarcely any segregation by routing of traffic has been undertaken in consideration of pavement service. In brief, states and cities have scarcely begun to administer their roads as a part of a transportation business.

"The Mountain Hath Labored—"

AS RECORDED in the news section of this issue the Board of Direction of the American Society of Civil Engineers has adopted a set of resolutions bearing upon registration for engineers. The resolutions are a disappointment. Nearly two years ago the board appointed a committee of five to study and report on the licensing question and since that time, this committee has been investigating, holding hearings and deliberating. Although its findings and conclusions have not yet been made available to the membership, the present resolutions, in all probability, are based upon the results of its studies. It is true that, as the resolutions indicate, the most diverse and inconclusive opinions on this subject prevail throughout the profession but few were prepared for so vague and fruitless a pronouncement by the board as is embodied in these resolutions.

Disappointment is increased, moreover, with the realization that the action now taken could just as well have been taken a year or more ago, and that had this been done the society might already have made a material contribution of the sort it now is talking about. The trend that is here "recognized" was just as obvious a year ago. It was a matter of record then that more than half the inhabitants of this country were living in states that had adopted registration laws. Everyone knew then that the various laws were not uniform and that many contained objectionable features. Many, indeed were highly exercised over the fact. Those who were at all familiar with developments knew that many state legislatures—notably some that meet only once in two years—would consider registration bills during their 1923 sessions. Now after two years of deliberation the board solemnly utters these commonplaces and instructs its committee to return in three months with a model law and a recommendation as to how the society is to do the things that might have been got under way a year or more ago. Truly the mountain hath labored and brought forth a mouse.

As the matter now stands, draft of a uniform law is to be submitted to the Board of Directors at its April meeting. Then, perhaps, it will be sent to a referendum of the society, for the resolutions provide that it "shall be approved by the society." By the time all this has come to pass summer will be upon us and practically all of the legislatures will have adjourned for two years. Meanwhile laws already passed will become effective, and desirable modifications will be far more difficult to bring about than they would have been heretofore. Valuable time has been lost and if the society is to make any effective contribution to this development, in which so many of its members are interested, it is earnestly to be hoped that the board will take definite and final action, so far as is within its power, at the April meeting.

Institutional Fire Protection

AS WAS to be expected, the terrible fire in the state asylum on Ward's Island in New York City where so many helpless inmates were killed, has aroused the state authorities to belated action. The governor has sent a special message to the legislature recommending a $50,000,000 bond issue to provide funds for the erection of new fire-safe buildings for state institutions and in so doing has called specific attention to the deficiencies in the existing structures. The intimation is that it took the fire to reveal all these defects and further that the only remedy is complete new construction.

Neither assumption is quite true. The deplorable conditions at Ward's Island were called to the attention of the state authorities as long ago as 1916 when the city, through H. F. J. Porter and A. L. A. Himmelwright, two local engineers, made extensive repairs to many of the city's institutional buildings which were veritable fire-traps. These repairs, described in *Engineering News*, Jan. 18, 1917, p. 101, were directed toward restricting the area of any fire and toward the easy removal of patients and inmates in case of fire mainly by horizontal passageways into separated sections. Similar action was recommended to the state for application to the Ward's Island buildings but the suggestion met no response and was therefore dropped by the engineers. The fact remains that for a comparatively small sum these buildings, since destroyed, could have been provided with fire walls and stops and with horizontal exits through automatic fire doors and the recent loss of life avoided.

Similar treatment can measurably add to the safety of many of the other buildings which the governor wants replaced. There is no doubt that new modern fireproof structures are much superior to old structures protected by such devices as are possible, but the cost of new structures may prove prohibitive. If the legislature is found to be in an economical mood it is imperative that at least some funds be appropriated for protective measures.

The lesson, too, may extend beyond New York State. Institutional buildings everywhere should be examined and, if found necessary, revamped not to make them fireproof, for that is impossible with an old structure, but to reduce the fire hazard and to make it reasonably certain that the more or less helpless inmates can be readily removed in case of fire.

Long-Span Steel Arch Bridge Over Niagara Gorge for Michigan Central R. R.

Well-Known Cantilever Bridge Will Be Replaced After 40 Years' Service by Two-Hinged Spandrel-Braced Arch of 640-Ft. Span, Carrying a Solid-Floor Independent Deck—Advanced Methods of Design

A LONG-SPAN double-track arch bridge will be built over the Niagara River gorge, just below the city of Niagara Falls, N. Y., to replace the old cantilever bridge of the Michigan Central R.R. The location of the new crossing resulted from an unusually thorough study of the local topography and other physical conditions, while the design of the structure itself represents a noteworthy application of advanced bridge engineering principles. At the present time the design and all preparations for construction are completed, and contract for the construction of the steelwork has been let to the American Bridge Co., work to begin this spring. The abutments and other items of substructure work will be built under a separate contract. A review of the design is presented herewith, on the basis of data supplied by J. F. Deimling, chief engineer, and H. Ibsen, special bridge engineer of the railway.

The new bridge is required because the cantilever bridge, now forty years old, has for a long time been much overloaded, and has been costly and troublesome to maintain, in addition to necessitating speed and load restrictions which have become more and more objectionable. The planning of a new bridge began in 1916 and has been much delayed as a result of the war. The old cantilever bridge controlled the location, both because of the narrowness of the gorge at this point and because of the existing track and yard facilities. Arch construction was early decided upon as best suited to the case, and a complete design was prepared for an arch to be built around the cantilever—the old alignment being retained, in spite of the great difficulty of such construction, because the charter for the old bridge narrowly restricted its location. Subsequent explorations of the subsoil to reveal the topography of rock surface made it evident, however, that on the line of the cantilever the span between suitable points for arch abutments would be much longer than on a slightly different line, 50 to 100 ft. downstream. The revised location afforded satisfactory abutments for an arch of 640 ft. span, as determined from rock contours and profiles obtained by means of some sixty vertical and inclined borings in the side of the gorge, while on the line of the cantilever a span of 700 ft. would be necessary. As indicated in the map Fig. 1 the new structure will be close alongside the old one at the west or Canadian end, thence diverging to the north as the American side is approached.

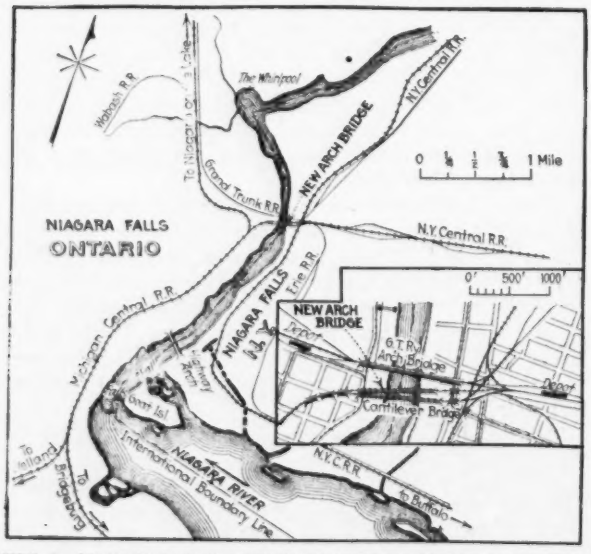


FIG. 1—NEW RAILWAY ARCH BRIDGE TO CROSS NIAGARA GORGE BETWEEN EXISTING CANTILEVER AND ARCH BRIDGES

FIG. 2—NIAGARA GORGE AT SITE OF NEW BRIDGE
Present cantilever bridge of Michigan Central R.R. seen looking from American toward Canadian bank; the new arch will be alongside and downstream, about on the line of the right-hand edge of the picture, where the shortest span between hard rock strata is obtained.

Old Bridge—The cantilever bridge, built in 1883, from designs of C. C. Schneider, has a main span of 495 ft. c. to c. towers. It was originally proportioned for a loading of two 66-ton locomotives followed by 2,000 lb. per foot of track, corresponding roughly to E23. By 1900 the cantilever was no longer of sufficient capacity, and a third (middle) truss was put in, with independent tower posts and pedestals for them; the stringers were doubled at the same time, and the capacity was thus brought up to E35. Subsequently various other repairs and improvements were made in the structure. The webs of the floorbeams developed cracks at their ends, from being bent transverse to their plane, caused partly by the restraining action of the stringers and of a separate wind chord added in 1891, that prevented the floorbeams, which are riveted to the truss post, from following the truss motion

under live-load strain, and partly by the pull of the lateral bracing, which is attached to the floorbeam web a short distance inward from the floorbeam connection. The connections of the floorbeams to the trusses were also poorly detailed. The floorbeam connections and the webs were repaired, and the lacing of the posts, which showed itself inadequate, was doubled. The hip pins in the anchor arms had worn into the web metal of their posts, and this wear was repaired by adjustable bars looped around the pin and supported on brackets riveted to the post. Other troubles could not readily be corrected, such as the imperfect working together of the

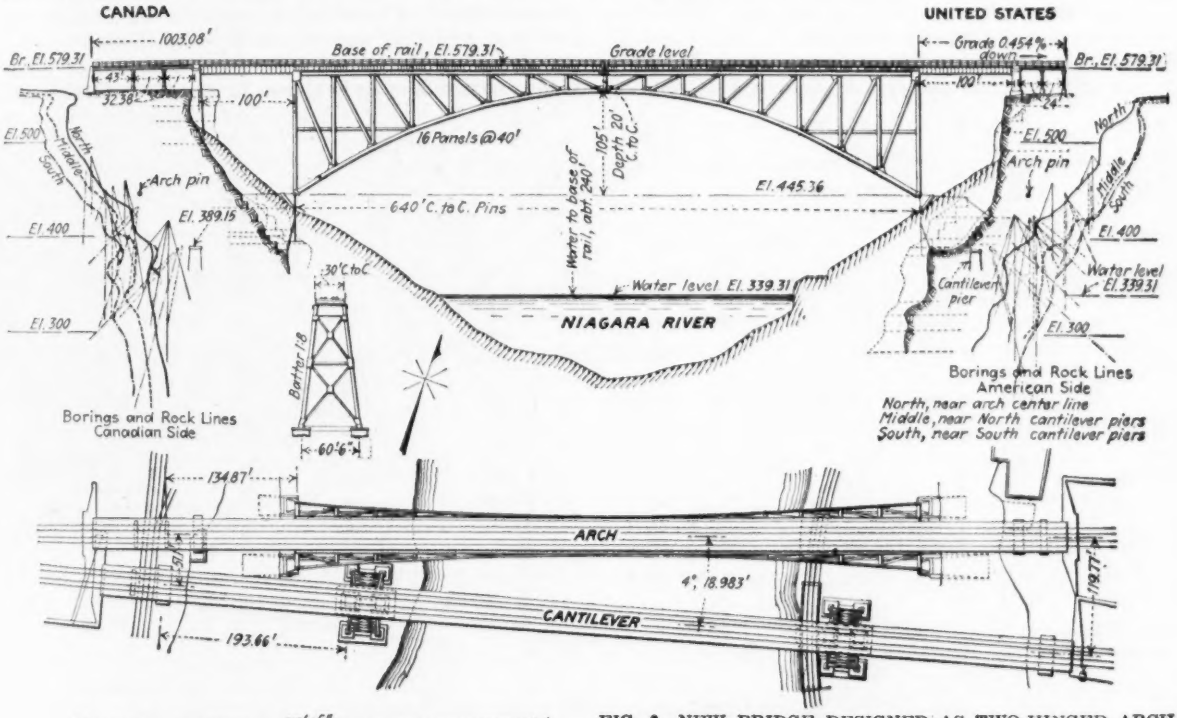
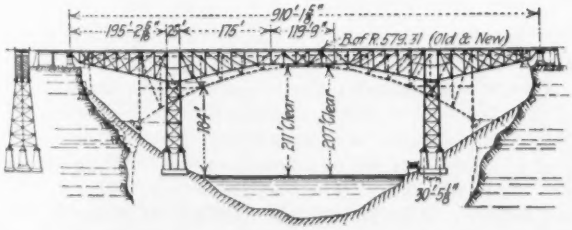


FIG. 3—NEW BRIDGE DESIGNED AS TWO-HINGED ARCH OF 640-FT. SPAN WITH TRACK 240 FT. ABOVE WATER



separate tension and compression members of the top chord, which was made up of eyebars inside a normal compression section, the former to take tension and the latter compression. The structure has required more or less constant attention. In the meantime traffic loads steadily increased; the maximum loading now permitted on the bridge is the equivalent of E45, operated at limited speed.

Gorge Conditions—Borings made alongside the tower pedestals of the cantilever bridge in 1900 showed that solid rock is about 200 ft. below water, and that the filling of the gorge bottom is a talus of large rock on which the cantilever bridge foundations rest. The river channel is grooved out in this talus mass, and according to two very careful series of soundings, the first made in 1900 and the second in 1918, carried out with 400- and 600-lb. cast-iron sounding weights from the deck of the cantilever bridge, is about 85 ft. deep at the middle, with general outline about as shown in Fig. 3. The walls of the gorge present horizontal strata of firm limestones, shales, and sandstones. An arch sprung between the gorge walls was the most natural and suitable solution of the problem of a heavy-capacity bridge under these circumstances.

At the top of the gorge walls there is found a 50-ft. thickness of Niagara limestone, under which is a bed of shale of about the same thickness. Directly below this shale about 20 ft. of Clinton limestone occurs, resting in turn on Medina shales and sandstones. Of the series, the Clinton, a hard and durable stratum, was the most suitable as support for the bridge abutments. Much of this stratum, however, is masked by a talus slope which covers the lower part of the gorge walls. The true outlines of the undisturbed rock surface were not known until the results of an exhaustive series of borings were available. From these results the shortest span between the Clinton limestone outcrops could be determined, and the present location is the result. In Fig. 3 is included a small-scale reproduction of the rock profile and the locations of the borings.

The plans for the new crossing required rail level to be at the same elevation as the present. However, as there are several grade crossings on both sides of the river, which may at some future time require a change of grade, the floor construction was worked out in such a way as to permit of raising the floor without affecting the main carrying structure.

General Design—As represented in Fig. 3, the arch designed to suit these conditions is of the two-hinged spandrel-braced type, in which respect it is similar to the 550-ft. arch close by. Its span is 640 ft. center to center of end pins, its bottom-chord rise 105 ft., and the crown depth 20 ft. The web system comprises

sixteen panels of 40 ft., but the floor panels are only one-third as long. The two arch trusses are spaced 30 ft. apart in the line of the top chord, and thence downward have an outward batter of 1:8.

The spandrel-braced two-hinged type of arch was adopted for superior rigidity and appearance, as against a rib arch. Appearance also dictated the parabolic curve of the bottom chord.

Full riveted construction was decided upon. Subsequently, on computation of the secondary stresses in the structure, it was found that the short web posts in the middle section of the arch would be subjected to excessively heavy bending, and for this reason four posts were detailed with pin connections at their ends. Except for these pins and the pins which form the skewback hinges, all connections are riveted. During erection and until completion of the structure, however, there will be a hinge at the crown of the bottom chord; the top chord is not to be connected until after completed erection, so that the dead-load stresses in the bridge will be those corresponding to three-hinged condition. It is intended to make the connection of the top chord (after setting the closing member) at the mean temperature assumed in the design (50 deg. F.), using in this process a device similar to that originated for the closure of the Hell Gate arch, where the last joint, brought into contact at the proper temperature, was held together by tie rods to prevent its separation until riveted up.

The floor construction, as already indicated, is decidedly novel. The entire floor rests on the top chord, and forms no part of the arch structure. Over each of the two top chords there is a line of longitudinal girders, carried on cast-steel shoes at the main panel points; transverse floorbeams are riveted between the girders at intervals corresponding to one-third the truss panel length, and the deck stringers rest on these floorbeams. Each main-panel section of floor is kept independent of the adjoining one, so as to form an expansion section by itself, and avoid participation of the floor in the arch stresses. The stringers, which are groups of four 15-in. I-beams under each rail, supplemented by edging and footwalk beams, are covered with a ¾-in. steel deck plate. The roadbed ballast will be placed on this plate after a layer of waterproofing with its bedding and cover of concrete is applied. At the ends of each expansion section the deck plate is edged by a transverse I-beam which forms a retaining curb for the ballast and is joined to the curb of the next floor section by a cap plate riveted to one of the two curbs.

In connection with the description of this remarkable deck construction (Fig. 7), it should be noted that the floor on the approach spans is closely similar to that on the arch, so far as the deck plate and parts above are concerned. The carrying members are transverse, however, and rest directly on the top flanges of the main girders. A section of the floor of the 100-ft. plate girder approach span is shown in Fig. 7, together with the deep transverse plate girder between the end posts of the arch which carries the approach span.

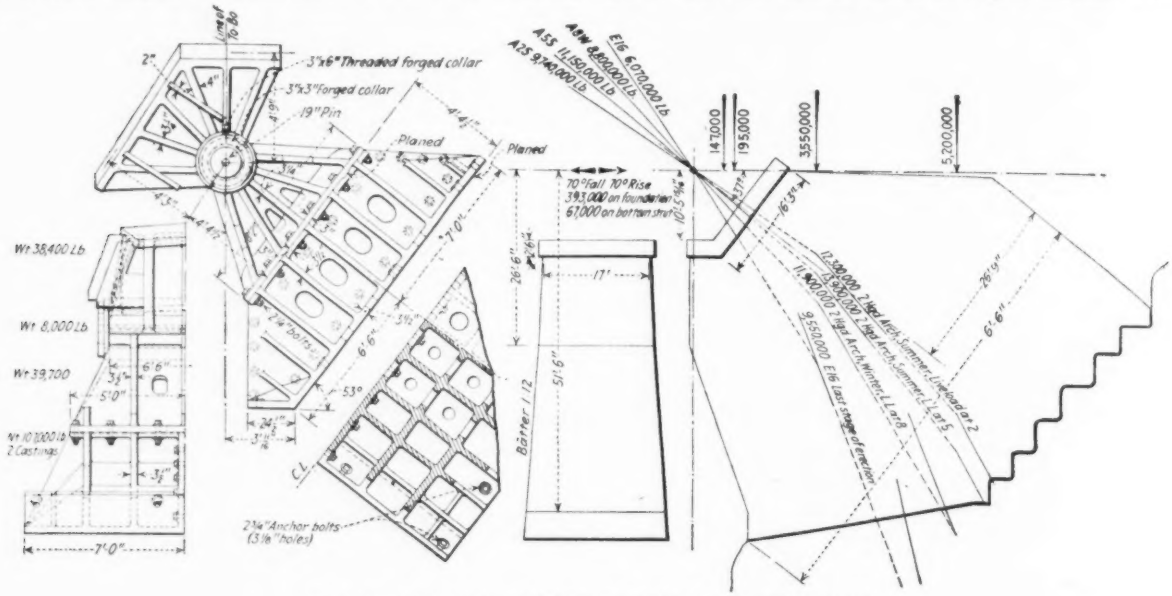


FIG. 4—END SHOE, CONCRETE PIER AND REACTIONS

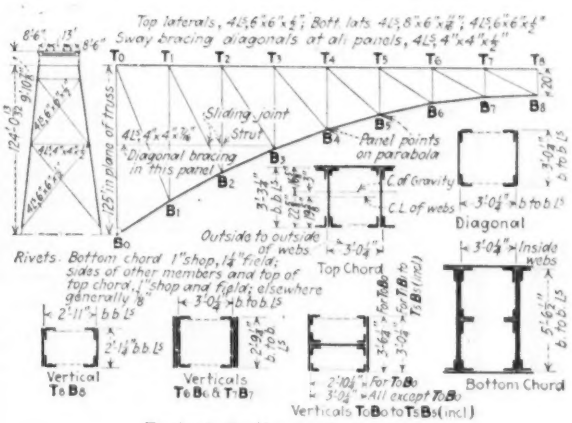
Design and Details—On account of the importance of the structure it was desired to provide for all future requirements as far as foreseeable. For this reason, a high live load was taken into account and full provision was made for lateral, longitudinal and all other forces and actions. All the separate elements of stress amenable to calculation were computed. Accordingly, high unit stresses could be used.

Dead-load stresses were computed for the three-hinged arch condition, this condition being maintained by the erection procedure until after the floor dead load is in place. Live-load stresses were computed for the two-hinged arch condition. Stresses due to wind, a separate transverse force, longitudinal or traction forces, and temperature were separately computed. Secondary stresses due to distortion under load were computed for the middle half of the bridge, outside of which length the members are of such proportions that the secondary stresses will be small. Torsion due to single-track loading and due to wind was computed by a method of approximation; the division of torsional moment at five separate cross-sections of the bridge was computed, and the shears in the laterals and truss webs for the five sections were then averaged, with the gen-

end result of assigning to the bottom laterals 65 per cent of the total resistance to wind pressure, to the top laterals 10 per cent, and to each arch 12½ per cent, which figures were used in determining stresses.

All these stresses except lateral and secondary were included in the computation of required cross-section by the normal unit stresses, noted below; secondary stresses were provided for by increase of cross-section only where they exceeded one-third of the axial stresses.

The design of members and details was carried out with a view to obtaining sturdy construction. Simplicity of connections was also sought, and for this reason the joints were made by two gussets, and splices were made without interleaving of webs. The bottom chord was designed as a box-shaped member of uniform depth throughout, composed of two I-shaped ribs and top and bottom cover plates. This member is very heavy, reaching a maximum cross-section of 714.8 sq.in. in the end


Top laterals, 4 L's 6"x6"x7/16"; Bott. lats. 4 L's 8"x6"x7/16"; 4 L's 6"x6"x7/16"
Sway bracing diagonals at all panels, 4 L's 4"x4"x7/16"
Sliding joint
Strut
Diagonal bracing in this panel
Panel points on parabola
C of Gravity
C.L of webs
Diagonal
Outside to outside of webs
Top Chord
Rivets: Bottom chord 1" shop, 1 1/4" field; sides of other members and top of top chord, 1" shop and field; elsewhere generally 7/8"
Vertical T0B0
Verticals T0B0 & T1B1
Verticals T0B0 to T5B5 (incl.)
Bottom Chord

Typical Sections of Members

TOP CHORD			BOTTOM CHORD			VERTICALS			DIAGONALS		
MEMBER	RESULTANT MAX. AND REVERSAL STRESSES	MAKE-UP	MEMBER	RESULTANT MAX. AND REVERSAL STRESSES	MAKE-UP	MEMBER	RESULTANT MAX. AND REVERSAL STRESSES	MAKE-UP	MEMBER	RESULTANT MAX. AND REVERSAL STRESSES	MAKE-UP
T0T1	Max. -487 Rev. +110 Req. 41 in.²	1 Cov. Pl., 53 x 7/8 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 4 Bott L's, 8x8x3/4 2 Webs, 39 x 1 3/8 Net 189.71 in.²	B0B1	Max. -9701 Req. 713 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 2 Cov. Pls., 60 x 1/16 2 Cov. Pls., 60 x 1 Gross 714.78 in.²	T0B0	Max. -2144 Req. 193 in.²	2 Pls., 42 x 1 4 Cor. L's, 8x8x7/8 4 Diaph. L's, 8x8x7/8 1 Web, 34 x 1 Gross 223.84 in.²	T0B1	Max. -614 Rev. +771 Req. 84.5 in.² Max. +1132 Rev. -293 Req. 75 in.²	2 Pls., 36 x 3/4 4 L's, 8x8x5/8 Gross 92.44 in.² Net 76.69 in.²
T1T2	Max. -964 Rev. +234 Req. 81 in.²	1 Cov. Pl., 53 x 7/8 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 4 Bott L's, 8x8x3/4 2 Webs, 39 x 1/4 Net 181.90 in.²	B1B2	Max. -9321 Req. 680 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 2 Cov. Pls., 60 x 1/16 2 Cov. Pls., 60 x 1/16 Gross 677.28 in.²	T1B1	Max. -1521 Rev. + 3 Req. 136 in.²	2 Pls., 36 x 3/4 4 Cor. L's, 8x8x5/8 4 Diaph. L's, 6x6x1/2 1 Web, 36 x 5/8 Gross 136.10 in.²	T1B2	Max. -628 Rev. +644 Req. 114 in.² Max. +1031 Rev. -278 Req. 74 in.²	2 Pls., 36 x 1 4 L's, 8x8x1 1/16 Gross 114.12 in.² Net 94.87 in.²
T2T3	Max. -1491 Rev. + 356 Req. 125 in.²	1 Cov. Pl., 53 x 7/8 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 4 Bott L's, 8x8x3/4 2 Webs, 39 x 15/16 Net 162.37 in.²	B2B3	Max. -9107 Req. 664 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 4 Cov. Pls., 60 x 1/16 Gross 662.28 in.²	T2B2	Max. -1391 Req. 148 in.²	2 Pls., 36 x 1 4 Cor. L's, 8x6x5/8 4 Diaph. L's, 6x6x1/2 1 Web, 36 x 5/8 Gross 150.94 in.²	T2B3	Max. -602 Rev. +542 Req. 87 in.² Max. +968 Rev. -221 Req. 67 in.²	Same as T0B1
T3T4	Max. -2057 Rev. + 430 Req. 170 in.²	1 Cov. Pl., 53 x 5/8 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 2 Bott L's, 8x8x5/8 2 Webs, 39 x 15/16 Gross 175.64 in.²	B3B4	Max. -8961 Req. 649 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 2 Cov. Pls., 60 x 1/16 2 Cov. Pls., 60 x 1/16 Gross 647.28 in.²	T3B3	Max. -1275 Req. 118 in.²	2 Pls., 36 x 5/8 4 Cor. L's, 8x6x1/2 4 Diaph. L's, 6x6x1/2 1 Web, 36 x 5/8 Gross 117.50 in.²	T3B4	Max. -543 Rev. +443 Req. 69 in.² Max. +934 Rev. -132 Req. 62 in.²	Do.
T4T5	Max. -2599 Rev. + 346 Req. 208 in.²	1 Cov. Pl., 53 x 3/4 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 4 Bott L's, 8x8x3/4 2 Webs, 39 x 1 3/16 Gross 209.08 in.²	B4B5	Max. -8860 Req. 637 in.²	Do.	T4B4 and T5B5	Max. {T4B4 -1171 T5B5 -1096 Req. {T4B4 = 97 in.² T5B5 = 84 in.²	2 Pls., 36 x 1/2 4 Cor. L's, 6x6x1/2 4 Diaph. L's, 6x6x1/2 1 Web, 36 x 5/8 Gross 104.5 in.²	T4B5	Max. -403 Rev. +529 Req. 55 in.² Max. +960 Req. 59 in.²	Do.
T5T6	Max. -2928 Rev. + 133 Req. 227 in.²	1 Cov. Pl., 53 x 7/8 2 Top L's, 5x5x5/8 2 Top L's, 8x8x5/8 4 Bott. L's, 8x8x3/4 2 Webs, 39 x 1 5/16 Gross 225.46 in.²	B5B6	Max. -8723 Req. 628 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 2 Cov. Pls., 60 x 1 1/16 2 Cov. Pls., 60 x 9/16 Gross 632.28 in.²	T5B6	Max. -1131 Rev. 0 Req. 81.5 in.² Max. +182 Rev. -757	4 Pls., 33 x 11/16 4 L's, 8x8x1 1/16 2 Pls., 16½ x 7/16 Gross 155.55 in.²	T5B6	Max. -594 Rev. +407 Req. 66 in.² Max. +1052 Rev. - 53 Req. 65 in.²	Do.
T6T7	Max. -2948 Req. 222 in.²	Do.	B6B7	Max. -8414 Req. 606 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 4 Cov. Pls., 60 x 5/8 Gross 617.28 in.²	T7B7	Max. -1146 Rev. + 49 Req. 82 in.² Max. +298 Rev. -861	4 Pls., 33 x 11/16 4 L's, 8x8x1 1/16 2 Pls., 16½ x 11/16 Gross 155.55 in.²	T6B7	Max. -1045 Rev. +718 Req. 115 in.² Max. +1374 Rev. - 374 Req. 93 in.²	2 Pls., 36 x 1 4 L's, 8x8x3/4 Gross 117.76 in.² Net 97.76 in.²
T7T8	Max. -2606 Req. 196 in.²	Do.	B7B8	Max. -7758 Req. 558 in.²	8 Webs, 66 x 5/8 12 L's, 8x8x3/4 2 Cov. Pls., 60 x 3/4 Gross 557.28 in.²	T8B8	Max. -717 Req. 51 in.²	2 Pls., 25 x 5/8 4 L's, 8x8x1 1/16 Gross 73.37 in.²	T7B8	Max. -1469 Rev. +1031 Req. 162 in.² Max. +1616 Rev. - 878 Req. 121 in.²	2 Pls., 36 x 1 4 L's, 8x8x3/4 2 Pls., 19 x 3/4 4 Flats 8 x 5/8 Gross 166.26 in.² Net 138.39 in.²

Stresses in 1000-lb. Units

FIG. 5—STRESS AND MAKE-UP SHEET FOR NEW NIAGARA ARCH

Design made for E70 train loading and based on unit stresses of 20,000 lb. per sq. in. for dead load and 18,000 lb. per sq.in. for live load. Ample wind and lateral and longitudinal force calculations were included, and secondary stresses were allowed for in the middle half of the structure, insofar as they exceed one-third of the primary stresses.

section, the latter forming a 70-ton erection piece. The field joints in the chord are faced to broken outline each outer third of the depth of the face being backed off ⅛ in. so that the bearing during erection is concentrated in the middle section and the joint can adjust itself to distortion until the splice is riveted up.

The top chord is of normal top-chord section, composed of two channel-shaped side members with cover plates. The posts have channel-shaped side members connected by a continuous longitudinal diaphragm. The diagonals are of similar section without a diaphragm. The open sides of all members are laced with stiff lacing,

generally composed of 6-in. channels attached on the inner face of the flanges.

The gusset plates, built into the chord members, are 1-in. and 1¼-in. plates. Their edges within the web of the chord are not planed to bearing but are fully cover-spliced.

Rivets ranging from ⅞ to 1¼ in. in diameter are used. In general, the bottom chord has 1-in. shop rivets and 1¼-in. field rivets, the side and top main connections of the top chord 1-in. rivets, the laterals and lacing of the same chord ⅞-in. rivets, the web members generally 1-in. rivets, and all minor parts ¾-in. rivets. In every case where the grip is over four diameters, taper rivets are specified; these have a diameter for 1-in. from the head ⅛ in. larger than the nominal size, and thence taper to a point diameter ⅛ smaller than the nominal size. Such rivets must have their points cooled.

Rather high-grade workmanship is specified for the fabrication of this structure. All main riveting is to have drilled or sub-punched and reamed holes, and quite detailed requirements are set up for the accuracy of match of holes. The arch is to be assembled in the shop yard in sections of three panels at a time, the connection holes being here drilled or reamed to the unstrained position of the members. The lengths of the members, however, are to be made to a camber equal to the deflection under dead load plus one-half live load plus impact.

At the skewbacks, a simple pin hinge was adopted, as contrasted with the circular roller bearing used in the near-by 550-ft. arch. The load is transferred by this pin to a cast-steel shoe having a base area 14 ft. x 14 ft. 8¾ in. where it rests against the abutment concrete. This shoe as finally designed consists of three pieces, the bottom section being formed of right and left halves while the top or pin section is one piece. The pin, 19 in. in diameter, is not seated in the steel of the chord but in a cast-steel pin casting which receives the end of the chord. Upper and lower pin castings are held together at either end of the pin bearing by a steel retainer collar 3x3 in. in cross-section.

The maximum thrust delivered to the abutment through the shoe is 11,150,000 lb. The change in inclination of the thrust under load and temperature variations is represented in Fig. 4.

In the same figure the form of the concrete abutments is represented. The four abutments differ considerably in size, according to the location of the edge of the hard rock stratum. They range in volume from 750 to 2,200 cu.yd. of concrete each. As the firm rock is covered by a considerable depth of talus at these points, a relatively large amount of excavation is required, totaling 28,000 cu.yd. for the four. The bedding surface for the shoe is to be dressed plane, and a ⅛-in. sheet of lead is to be placed under the casting.

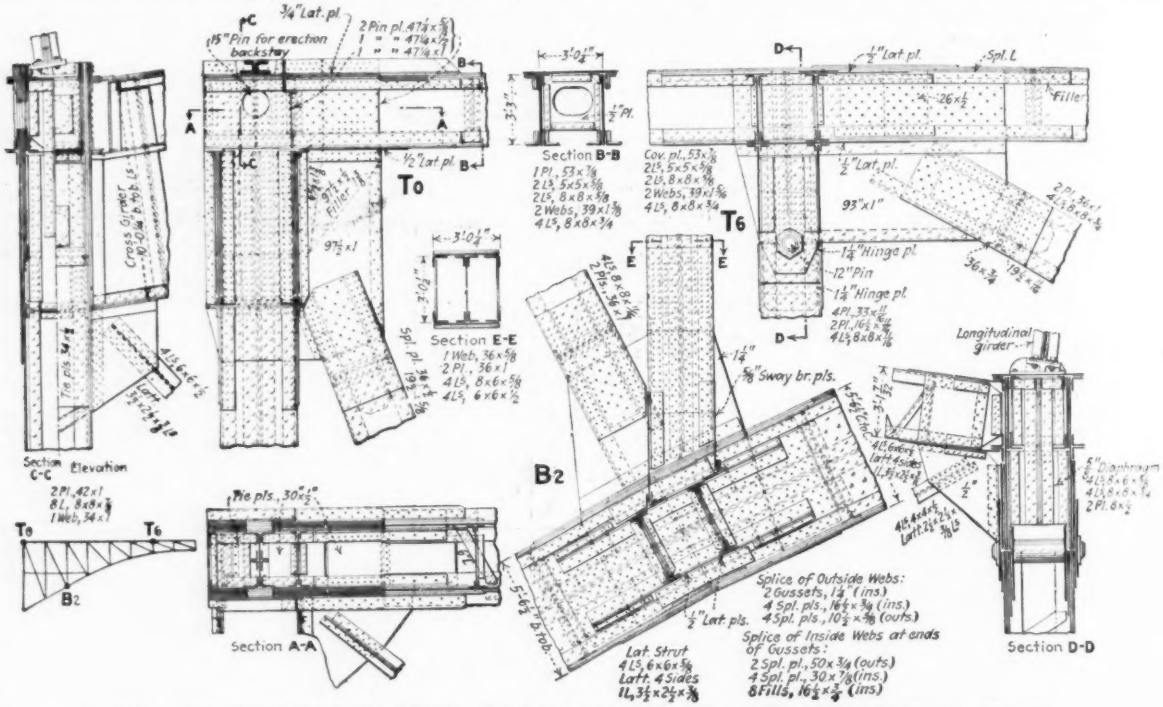


FIG. 6—REPRESENTATIVE DETAILS OF MICHIGAN CENTRAL ARCH OVER NIAGARA GORGE

The detailing is exceptionally simple for a structure involving members of maximum proportions. Two-web construction and pairs of 1¼-in. gusset plates are used in the chords. All latticing is made of angles or channels. The 1 to 8 batter of the two arch trusses affects only the lateral bracing connections and cast-steel floor girder pedestals.

Material—Normal bridge steel or mild steel will be used in constructing this bridge, with specified ultimate strength of 56,000 to 64,000, elastic limit 33,000 minimum, and elongation 25 per cent (less for thick material, down to 20 per cent). Rivet steel will be softer, with 46,000 to 54,000 ultimate, 28,000 elastic limit, and 30 per cent elongation. All material is required to stand a bend test, which for the structural material is flat closing for thicknesses of ⅞ in. or less, ranging to a bend around twice the thickness of the piece for thicknesses over 1¼ in.

Medium or high-carbon steel was not considered desirable for this bridge. Alloy steel was considered, but in the opinion of the engineers its use was not warranted if its cost exceeded that of ordinary steel by more than 1 cent per pound. Present differences of price are considerably greater than this.

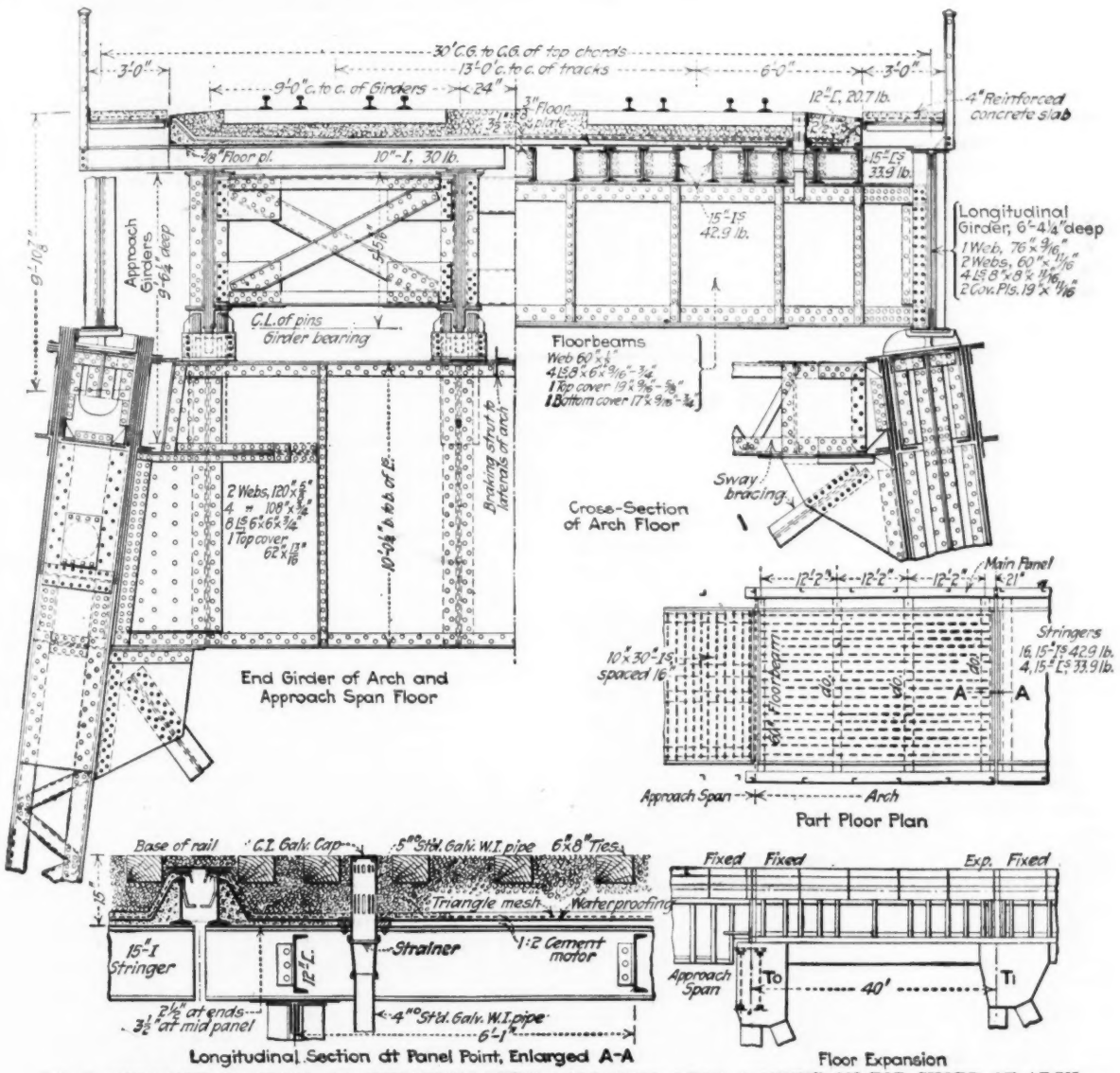


FIG. 7—SUB-PANELED FLOOR CONSTRUCTION WITH BALLASTED DECK, RESTING ON TOP CHORD OF ARCH

Design Data—The floor of the bridge was designed for Cooper's E70 locomotive loading (two consolidation locomotives, 2-8-0, with 70,000-lb. driving axles spaced 5 ft., representing a total load of 994,000 lb. on a 104-ft. wheel base, followed by 7,000 lb. per foot of track). For the arch members this wheel loading was replaced by a uniform load of 7,000 lb. per foot following a 110-ft. length of 9,000 lb. per foot of track. These loadings are higher than the New York Central Lines' standard for a 640-ft. span, which is E65; it was believed that for so important a structure a larger margin for future development should be allowed. However, as the unit stresses are higher than those generally employed, the actual design is substantially the same as would have resulted from E65 loading with ordinary unit stresses.

In applying this loading, stresses from double-track loading were reduced by 5 per cent. The transverse-beam deck of the approach spans was proportioned for a load of 18,000 lb. per foot of track, distributed over a 10-ft. width, while the longitudinal-beam deck of the main span was proportioned for the E70 wheel loading direct. Live-load stresses were increased by an impact allowance equal to half that of the Turneaure formula, or $\frac{15{,}000}{30{,}000 + L}$, where L is the span (or the floor panel length), but 10 per cent was used as minimum impact. For the beams of the approach-span deck, the impact was taken as 50 per cent.

Wind pressure was taken as 30 lb. per square foot on 1½ times the vertical projection of the bridge, plus 360 lb. per lineal foot applied 8 ft. above the rail; all these pressures were considered for a position of the deck 15 ft. higher than its original position. During erection, a 50-lb. wind on one and one-half times the elevation of the bridge and the traveler is to be taken into account. In addition to the normal wind pressure, the completed bridge was also required to withstand a transverse force, due to the train, of 500 lb. per lineal foot of bridge applied 6 ft. above the rail. Similarly, a longitudinal force applied at the same height was taken into account, amounting to 10 per cent of the live

load for the arch and 20 per cent on the minor spans. Temperatures changes of ± 70 deg. F. were considered.

Wind and lateral-force stresses were ignored where they did not exceed 25 per cent of the sum of other stresses (except secondaries). Secondaries, whose computation has already been referred to, were similarly ignored where they did not exceed one-third the combined axial stresses not including those due to wind and lateral force.

Two sets of unit stresses were used in proportioning the members, those applicable to live-load stresses being about nine-tenths as great as those applicable to dead-load and erection stresses. The principal figures are: tension on net section, 20,000 for dead load and erection, 18,000 for live load; compression on gross section, 18,000 — 80 l/r with 17,000 lb. maximum, and 16,000 — 70 l/r with 15,000 maximum; shear, 15,000 and 13,500; pin bearing, 27,000 and 24,000, except that for reversing bearing pressure half this stress was used; rivet bearing, 30,000 and 27,000. Except for bearing pressure, cast steel was figured at 10 per cent lower unit stresses.

In the application of these stresses several special provisions were considered, among which the following are important: Connections and splices were designed 10 per cent stronger than their members. All compression splices were made full, and were proportioned for a stress in the splice material of 16,000 lb. on gross section. Countersunk rivets and field rivets were increased in number by 25 per cent over the number of shop rivets required. Members carrying reversed stress were proportioned separately for each kind of stress increased by one-half the smaller, and end connections were proportioned for the sum of the separate stresses. The riveting was increased one-third for each filler plate between splice plate and main plate, and 1 per cent for each $\frac{1}{8}$ in. by which the grip exceeded four diameters.

Columns were limited to a length of 100 radii for main members and 120 for bracing members. In all

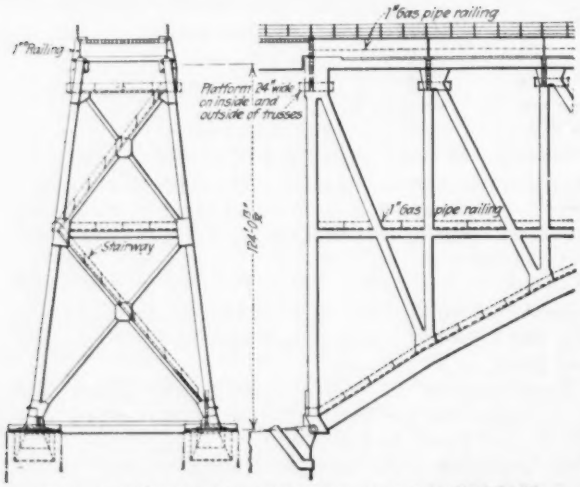


FIG. 8—INSPECTION LADDERS AND PLATFORMS

columns a shear of 300 times the cross-sectional area was provided for, except that in case of a longitudinal diaphragm the lacing was allotted only half the shear.

Erection—Each half of the arch will be erected as a cantilever, being held by an eyebar tie running back to an anchorage in the upper part of the cliff side. One such anchorage is sketched in Fig. 9; the steel anchor girders and tie members up to the face of the rock are to be left in place, after casing in concrete.

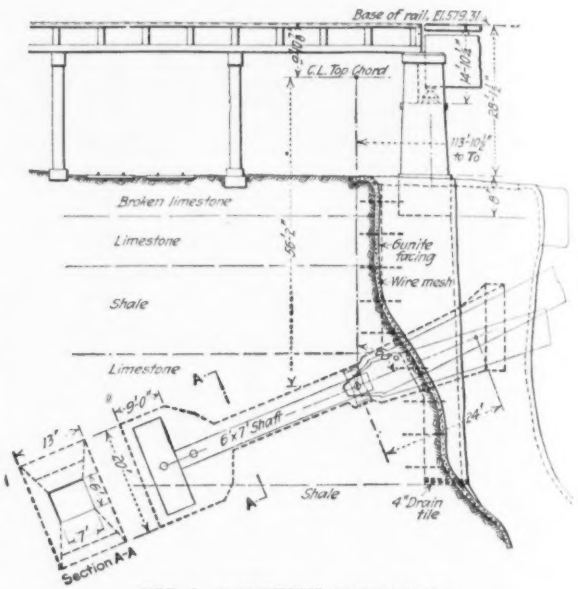


FIG. 9—ERECTION ANCHORAGE
The steel anchor members will be left in place, encased in concrete.

The bottom-chord splices are not to be riveted until the arch is joined at the crown of the bottom chord. The top chord center joint is not to be drilled or riveted until after the complete arch structure and the floor steel are in place, so that all these dead loads will be resisted by three-hinged arch action. The top-chord joint is then to be brought to bearing at 50 deg. F., and the abutting segments held together by ties until the joint splice is drilled and riveted.

Provision will be made in the members of one-half of one of the two arches for strain-gage readings, by twelve gage-point holes drilled in each member. It is intended to make such readings before, during and after erection and under live load, so as to obtain accurate information concerning stresses.

Quantities—The structure of the arch itself includes 4,800 tons of steel, including bracing and castings. A further weight of 1,250 tons of steelwork is contained in the floor. Nearly 1,500 tons of steel are required for the two 100-ft. approach girder spans, the adjoining street spans and the erection backstays, making the total steel weight 7,500 tons. About 11,000 cu.yd. of concrete will be required in the abutments and auxiliary foundations.

The contract price for the steelwork, erected, is about $116 per ton, of which about $7 is freight from fabricating shop to site.

The design of the bridge was developed under the direction of H. Ibsen, special bridge engineer, Michigan Central R.R., assisted by C. L. Christensen, assistant bridge engineer. The project is under the general direction of J. F. Deimling, chief engineer of the railway. Col. George H. Webb, late chief engineer, had the general direction of the project from its start until he went to France in 1917 as lieutenant-colonel with the 16th (Railway) Engineers, and again after his return in April, 1919, until his death on Nov. 3, 1921. Olaf Hoff, consulting engineer, is acting as advisory engineer on the project.

Some Tests of Light-Weight Aggregate

By Harry V. Mathews
Midwest Gas Plant, Salt Creek, Wyo.

A LIMITED series of strength tests on concrete made from the light-weight aggregate known as Haydite made last summer for the Midwest Refining Co., gives some indication of the strength to be expected from this aggregate. The plant for making the aggregate was built by the company because of the scarcity of natural aggregate in the Salt Creek oil field, where some concrete work had to be done. Haydite, as described in earlier issues of *Engineering News-Record*, is made by grinding shale and burning it in a rotary kiln. The burning expands the water in the shale and blows it up so that it is porous and looks a little like coke. The Haydite is then cooled and crushed to any desired size.

In all, twelve samples were made and tested. For comparison samples were made of bank run gravel and crushed rock. In the accompanying table, the letters *A*, *B* and *C* stand for different sizes of Haydite, *A* being from dust to ¼ in. and weighing 53 lb. per cubic foot dry, *B* from ¼ to ⅜ in. and weighing 46 lb. per cubic foot dry, and *C* from ⅜ to 1¼ in. *S* stands for sand and *SR* for sandrock.

TABLE SHOWING COMPARATIVE COMPRESSIVE STRENGTH OF SAND AND HAYDITE AGGREGATE

Sample No.	Wt. per Cu.Ft. Lb.	Mix	Unit Stress Lb. per Sq.In.	Remarks
1	136	1 : 3 : 3 (S SR)	1,260	Little too wet
2	136	1 : 3 : 3 (S SR)	2,045	Very good mix
3	89.7	1 : 1 : 1 : 1 (A B C)	1,965	Too wet to tamp
4	91.2	1 : 2 : 1 : 1 (A B C)	2,680	Good mix
5	88.7	1 : 2 : 2 : 1 (A B)	1,910	Good mix
6	88.3	1 : 3 : 2 (A B)	2,385	Too dry
7	77.8	1 : 4 : 2 (A B)	1,230	Too dry
9	108	1 : 3 : 1 : 2 (S A B)	1,745	Little too wet
10	112.2	1 : 2 : 3 (A SR)	2,310	Very good mix
11	78.5	1 : 3 : 2 (A B)	1,210	Too wet
13	77.3	1 : 3 : 2 (A B)	820	Very wet

All samples were 6 x 12-in. cylinders. The Haydite was soaked in water before being used in concrete, as it will absorb 12 per cent by weight of water.

A great deal of trouble has been experienced in using Haydite for concrete, due principally to its lightness. The aggregate will not flow on being tamped as will ordinary concrete and when there are irregularities in the forms such as floor benches, etc., it is hard to fill these up completely. On removing the forms, the concrete does not have as smooth an appearance as ordinary concrete and takes more time to finish.

The tests were made by the gas department of the company, of which W. R. Finney is superintendent. The writer is superintendent of the Salt Creek Gas Plant.

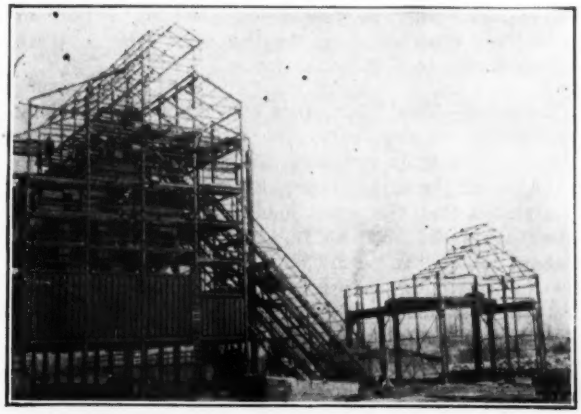
Puzzolan Cement Used on Federal Aid Road

On certain of federal-aid roads in Jefferson County, Ala., puzzolan cement has been used for the concrete base course. About three years ago the county requested the Bureau of Public Roads to approve this cement for such courses and after investigation of the specifications the Bureau consented. The cement used is a slag cement manufactured in Birmingham, where there is a good deal of concrete base course work made from the cement. This concrete is satisfactory, the Bureau reports.

Electric Crushing and Screening Plant at Quarry

Rope Drive for Main Crushers—Direct Connection for Most Machines—Waste Stone and Stripping Fill Old Workings

A NEW STONE CRUSHING and screening plant with an output capacity of 10,000 tons per 8-hour day, built recently at Marblehead, Ohio, by the Kelley Island Lime & Transport Co., has the following special features: (1) Electrical operation throughout, with individual drives; (2) gyratory crushers for both main and secondary crushing; (3) combinations of rotary and shaking screens and pan and belt conveyors including pan conveyors of exceptional length; (4) extensive weighing equipment. The plant produces crushed stone in numerous sizes, stone for limekilns and furnace flux and ground limestone for agricultural use. A view of the plant is shown in the accompanying illustration.



STONE CRUSHING AND SCREENING PLANT
Building at right covers crusher pit 40 ft. deep. Inclined conveyor delivers stone to top of screenhouse at left. Bins in lower part of house deliver stone to railway cars standing below. Quarry car at right.

Quarry—On about 400 acres of a 3,000-acre property the top ledge is being worked to a depth of 22 to 25 ft. along a face aggregating 3½ miles. A 12-in. loam overburden is removed by light traction steam shovels, the stripping being used to cover quarried areas which have been filled with waste rock. Blast holes are put down with well drills and the stone is loaded into quarry cars by large steam shovels. One of these machines is mounted on crawlers and is said to be the first steam shovel thus equipped for work in quarries. Geared locomotives handle the cars between the quarry and crushing plant.

Crusher Plant—Two steel-frame buildings housing the crushers and screens are connected by an inclined gallery for the conveyor which extends from the crusher pit to the top of the screen house. Large steel-sash windows are provided in the corrugated sheathing and roof ventilators are expected to create an upward draft which will carry away much of the dust. Electric current purchased from a utility company is brought in over a 12-mile transmission line. Individual motors are used and in most cases are geared directly to their machines, but rope and belt drive is used where shocks and irregular load must be considered, as in the case of crushers. In view of the dusty character of the work

all motors are fully inclosed and have dust-proof bearings.

Crushers — Two gyratory crushers with receiving openings 48 x 125 in. perform the main crushing and are placed in a pit with their tops 10 ft. below the surface tracks for the quarry cars. Above them is a steel bin having its bottom level with the tops of the crushers, the stone forming its own hoppers as it feeds through the openings into the crushers. With tracks along both sides of the pit two trains of three 10-yd. side-dump cars can be dumped at once into the bin. This arrangement dispenses with dumping inclines, and the cars do not have to be uncoupled. If a car does not dump promptly, its body is tilted by the piston rod of a compressed-air cylinder below the track. In erection, a railway wrecking crane handled crusher parts weighing 34, 38 and 60 tons, but a 50-ton overhead traveling crane provides for renewals of heavy parts. Each crusher is operated by a 200-hp. motor by means of a rope drive having twenty-six turns of ¾-in. rope. The 6- to 8-in. oversize material from the initial screens is suitable for charging into limekilns, but when necessary this material may be further crushed by a pair of smaller gyratory crushers in the screen house, each crusher belted to a 75-hp. motor.

Conveyors—Two 72-in. pan conveyors 176 ft. long and inclined 45 deg. carry the product from the discharge of the main crushers, 38 ft. below the ground to the top of the screen house, 88 ft. above the ground. It is stated that the great load which such conveyors impose upon the head shaft usually limits the length to about 130 ft. To permit of the greater length in this case an equalizing device is placed in the supporting trestle at about 65 ft. below the head shaft. This device takes the entire dead load up to that elevation, leaving the head shaft to carry only 65 ft. of the dead load and all the live load. These conveyors are operated by 200-hp. motors with silent chain drives and speed-reduction gearing.

Belt conveyors 20 in. wide take the screen product of less than ⅜-in. size and deliver it to a vibrating screen for smaller sizes. Belt and bucket elevators return the product of the secondary crushers to the 60-in. main screens.

Screens—Stone from the pan conveyors is discharged into two revolving screens 5 x 24 ft. The first half of the length has 3-in. circular holes and is surrounded by a jacket having 2½ in. holes, while the second half has openings 6 x 6 in. Material from these last large holes and the rejections from the jacket are stored for use as furnace flux. For grading into various commercial sizes the 2½-in. material goes to a second battery of revolving screens 4 x 20-ft. and thence to double-deck shaking screens, the rejections going to a vibrating screen which makes the final sizing for ⅜-in., ¼-in. and "dust."

Tracks and Scales—About 20 miles of 36-in. track serve the quarry and crushing plant, but all tracks at the screenhouse have three rails so that the product can be loaded into standard-gage cars for rail shipment or into the narrow gage quarry cars for transfer to limekilns, a boat dock or an agricultural grinding plant. In each of four tracks passing under the storage bins is a track scale, and cars standing on the scales are loaded by bottom discharge gates of the scissors type. Four air-operated quadrant gates with hinged spouts can load cars on a track alongside the oversize bins.

This crushing plant was designed and built by the Allis-Chalmers Mfg. Co., Milwaukee, Wis.; the steel buildings were designed by the Jones & Laughlin Co., Pittsburgh, Pa., and erected by the Massillon Bridge Co., Massillon, Ohio. All plans were prepared in cooperation with the Kelley Island Lime & Transport Co. Foundation work and installation of machinery was handled by this company under the direction of I. J. Sauvey, superintendent of construction, and A. C. Schultz, chief engineer.

Practical Arrangement of Building Codes

By Frank Burton
Commissioner of Buildings, Detroit

CRITICIZING building codes as being burdensome to both designer and builder by their illogical arrangement, Mr. Burton in a paper on "Essentials of a Building Code," read before the Michigan Engineering Society on Feb. 9, suggested in outline how a code might be arranged for practical usability, as reproduced here.

Building codes are a very heterogeneous hodge-podge of don'ts and shan'ts, and I honestly cannot criticize a builder who loses faith with a code and goes ahead the best way he knows how. Those who write building codes must first get clearly in their mind just what they are writing about. Then they must assemble this material in a logical sequence and place it before the builder in an orderly manner so that he can grasp the subject without an unreasonable amount of study:

(1) Types of construction, such as fireproof construction, mill construction, etc. Describe each type completely, starting with bearing walls, columns, and then going to floors, roofs, pent houses, roof structures, porches, windows, etc., so that no element of construction is left in doubt. Then classify the buildings definitely as to their use, such as factories, theaters, apartment houses, giving as many classes as are necessary but no more than are necessary. Under each class of buildings should be assembled all data pertaining to that class of building, even though this may mean repetition in some cases. For example, under factory buildings there should be discussed, first, the type of construction to be used, depending on height, size, etc.

(2) Mixed occupancy, such as using one part of the building for a garage or theater.

(3) Stair requirements.

(4) Shaft enclosures.

(5) Fire area requirements.

(6) Protection from fire on the lot line side, such as fire windows.

(7) Fire protection apparatus, such as standpipes and sprinklers.

(8) Special protection, such as setting of furnaces and other heating apparatus.

(9) Exceptions to the general rules which may be allowed in particular cases.

Two other subjects could probably be discussed here, since all the requirements mentioned above would pertain to new buildings. We should give the requirements for old buildings which ought to be improved and put in better condition; also, the requirements for existing buildings where it is desired to use them for other types of occupancy.

This scheme does not take in the question of engineering features, which will be entirely independent of both type of construction and class of occupancy and should properly be kept separate from the general outline. Engineering data are usually grouped for use by theoretical persons rather than practical builders; for example, most codes devote sections to the subject of stresses in the abstract, another to materials, and still another to methods of calculation. When a practical builder wishes to erect a mill building and wishes to determine the requirements for his timber members, he must read portions of three or four articles in order to get the data needed. My idea is to collect in one place all of the data regarding materials, stresses, methods of calculation of timber, steel or concrete members.

The Apulian Aqueduct—Southern Italy's Water Supply

Most Extensive System of Its Kind in World Nears Completion After 16 Years' Building—Serves 266 Municipalities Comprising a Population of 3,000,000

By I. Gutmann
With the Hydraulic Division of the Electric Bond & Share Co., New York City

THE Apulian Aqueduct in Southern Italy, which after sixteen years of work is now nearing completion, is a unique example of co-operation in water supply. It supplies water not to just one municipality, nor to one compact cluster of municipalities forming a metropolitan district, but to fully 266 communities scattered over an area of some 8,100 sq.miles, having a total population of some 3,000,000 people. This estimate is based upon partial returns of the census taken on Dec. 1, 1921. To this region, which is on the Eastern, Adriatic slope of the Appennine Peninsula, the aqueduct brings water from a remote watershed on the Western, Tyrrhenian slope of the peninsula, piercing in its course the backbone of the Appennine Mountains.

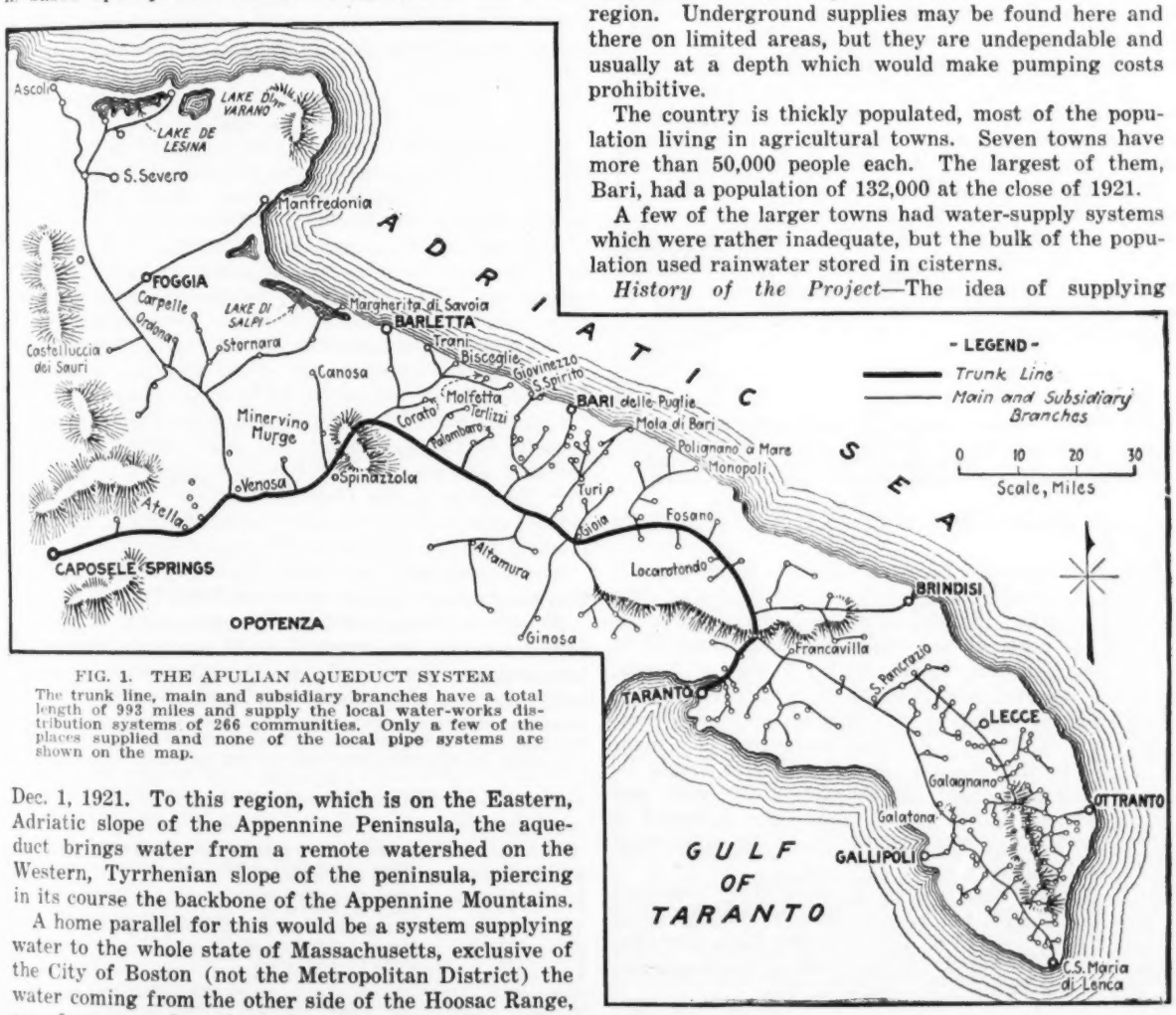


FIG. 1. THE APULIAN AQUEDUCT SYSTEM
The trunk line, main and subsidiary branches have a total length of 993 miles and supply the local water-works distribution systems of 266 communities. Only a few of the places supplied and none of the local pipe systems are shown on the map.

A home parallel for this would be a system supplying water to the whole state of Massachusetts, exclusive of the City of Boston (not the Metropolitan District) the water coming from the other side of the Hoosac Range, say, from some hypothetical springs above Troy, New York.

The Region of Apulia—The region served by the aqueduct is ancient Apulia, now subdivided into the three administrative provinces of Foggia, Bari and Lecce. It is the heel portion of the famous boot shape of the Appennine Peninsula—a country of irregular topography abounding with seismic faults and famous for violent, devastating earthquakes. The region is fertile though its climate is arid. It is in general not unlike the Los Angeles region in California. The yearly rainfall varies from 15 to 25 in. No rain falls in summer. The country is on a porous often fractured calcareous formation which rises from the Adriatic in a series of terraces finally attaining an elevation of a thousand feet above sea level. The runoff is rapid. What remains of the rainfall sinks very rapidly in the fissured tufaceous limestone. There are neither perennial streams or reliable impervious reservoir sites in this region. Underground supplies may be found here and there on limited areas, but they are undependable and usually at a depth which would make pumping costs prohibitive.

The country is thickly populated, most of the population living in agricultural towns. Seven towns have more than 50,000 people each. The largest of them, Bari, had a population of 132,000 at the close of 1921.

A few of the larger towns had water-supply systems which were rather inadequate, but the bulk of the population used rainwater stored in cisterns.

History of the Project—The idea of supplying "Thirsty Apulia" with water from the more humid western slope of the Apennines occurred first to a humble government engineer, Adjutant Rosalba, who, in 1868, pointed out the Sanita Springs of Caposele, at the head of the river Sele, as a desirable source for a water supply for Apulia. But in those days the Appennine Range was considered an insurmountable obstacle, and Rosalba's scheme was put aside as utopian. Twenty years later the project was studied in detail by Zampari who

prepared fairly detailed plans for its constructions. But even then no construction company would dare tackle so vast a project. Urged by Apulian representatives, the Italian Government appropriated in 1901 a fund of almost $200,000 for the completion of the technical report. The project was criticized by some engineers and geologists, notably by M. F. Casarti, who called it a "national error" from both the economical and technical standpoints. The opponents argued that a long aqueduct line was unsafe in a fault-fractured country subject to violent earthquakes. It was also claimed that local artesian supplies were obtainable at

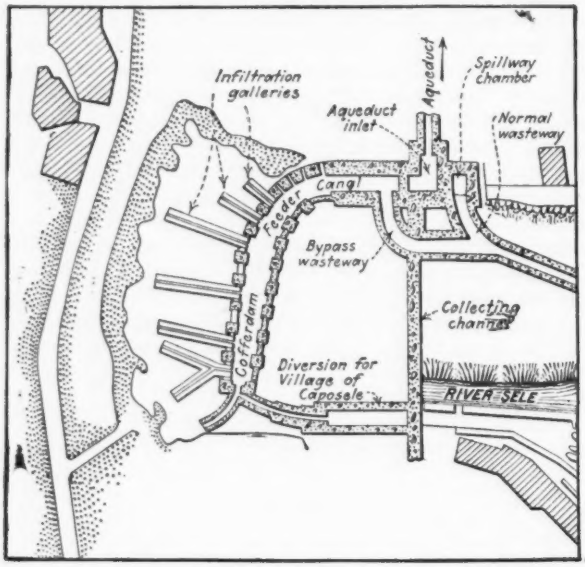


FIG. 2. PLAN OF HEADWORKS OF APULIAN AQUEDUCT
"Tapping galleries" empty into a collecting channel which leads to a feeder canal terminating in the equeduct intake.

reasonable depths (130 ft. or more) in many districts in Apulia.

A detailed technical report by Michele Maglietta was published by the Ministry of Public Works, under date of Oct. 20, 1902. In 1905, after an international competition, the contract and concession were awarded to the construction firm, Ercole Antico & Soci, of Genoa. It may be observed here that the rather delicate matter of adjudicating water to non-riparian provinces, completely outside of the watershed, transpired in a manner which in the Western American states would be deemed quite unexciting. At the end of 1906 work was commenced and in April, 1915, water was delivered at the City of Bari, on the Adriatic, about 120 miles from the Caposele Springs.

At the present time most of the work in the provinces of Bari and Foggia has been completed. Nearly all of the work remaining to be done is in the Lecce Division, where some very difficult construction is contemplated; the design calls for a siphon 75 miles long.

General Layout—The Apulian Aqueduct, conducting water from one source of supply to 266 centers of demand scattered over an area of 8,100 sq. miles, necessitates a system of conduits on this general plan: One main trunk from the springs to the territory served, diverging into systems of main and subsidiary branches, finally terminating in the various communities served. The main trunk of the Apulian Aqueduct (Fig. 1) commences at the Caposele Springs, very soon pierces the Appennine Range in a nearly eastern direction by means of a series of 38 grade tunnels, totaling almost 50 miles in length and comes within about 15 miles of the Adriatic Coast. Thence it turns southeast, generally paralleling the coast, and terminates about 90 miles away, at Villa Castelli, in the province of Lecce. This stretch is largely a cut-and-cover conduit. The total length of the main trunk is almost 152 miles (244 km.). It comprises 99 tunnels of about 67 miles total length, about 76 miles of cut-and-cover conduit; 93 aqueduct bridges totaling 4.25 miles in length; and 6 siphons of a total length of 4.6 miles.

From this main trunk branches are sent out to the various towns and their districts: Foggia, Bari, Brindisi, Taranto, etc.

The total length of supply conduits will be 993 miles: 152 miles of main trunk and 841 miles of main and subsidiary branches. There will be in addition about 550 miles of distribution mains and service pipes within the municipalities served. Compared with this, the Coolgardie pipe line, in Australia, heretofore considered the longest in the world, is 350 miles long, and the Los Angeles Aqueduct, which is the longest in America, is about 240 miles in length.

The topography of the country traversed is very irregular, it being crossed by many ridges, gorges and stream beds. At some points, it was necessay to insert drops. The energy developed at the various drops will be utilized for the generation of a total of 8,500 hp. Of this, about 7,000 hp. will be taken up by industrial enterprises. The remainder, augmented with power from other sources, will be used for pumping water to points which are inaccessible to the gravity flow of the aqueduct. The greater part of the territory south of the city of Lecce will be served from pumping plants.

Capacity and Rates of Consumption—The maximum capacity of the aqueduct is 137 m.g.d., which is about one-half the capacity of the Los Angeles aqueduct. For the present, the Caposele Springs have been developed only to the extent of yielding 126 m.g.d. but this is about 100 per cent above the present demand.

The allowed daily per capita rates of consumption fall into eight categories, as shown by Table I.

Storage—Covered distribution reservoirs of reinforced concrete are provided at all the important centers served. There will be 152 such reservoirs of a total capacity of 76,000,000 gal.; the largest one, at

TABLE I. PER CAPITA CONSUMPTION ALLOWANCES FOR VARIOUS CLASSES OF COMMUNITIES SERVED BY APULIAN AQUEDUCT SYSTEM

	Gal. per Cap. per Day	
	For Communities with a Gravity Supply	
1	24	For the Cities of Bari, Lecce, Foggia, Barletta, Taranto
2	18.5	Towns of more than 20,000
3	16	Towns of 10,000-20,000
4	14.5	Towns of 5,000-10,000
5	13.25	Towns of 5,000 or less
	For Communities with a Pumped Supply	
6	13.25	Towns of 10,000 or more
7	12	Towns of 5,000-10,000
8	10.6	Towns of 5,000 or less

Taranto, will hold 4,227,000 gal. The population of Taranto probable exceeds 75,000. As to capacity, these reservoirs have been designed to store a normal 48-hour supply for points along a descending conduit line, and a 72-hour supply for points along an ascending conduit. For reservoirs in the Bari division, which is close to the main trunk, the reserve-storage is for normal supplies of only 30 and 56 hours respectively.

This is by no means excessive in a country subject to violent earthquakes which may cause in the main-trunk-

structures damage requiring much over 72 hours to repair. Nor is it excessive for a system in which only a few of the centers of consumption are less than 75 miles away from the source of supply. The Catskill Aqueduct, which is located in a non-seismic country, is provided with more than 72 days reserve-storage almost within the city limits of New York. Kensico and Hill View have a storage capacity of nearly 40 billion gallons. The Los Angeles Aqueduct, which like the Apulian traverses an earthquake region, is provided at its terminus with a reserve storage equal to half a year's supply. Chatworth and the two San Fernando reservoirs have a capacity of about 22 billion gallons. The similarly situated city of San Francisco is even better provided against emergencies along its comparatively short aqueduct line. It should be hoped that means will be found to remedy this weakness of the Apulian Aqueduct.

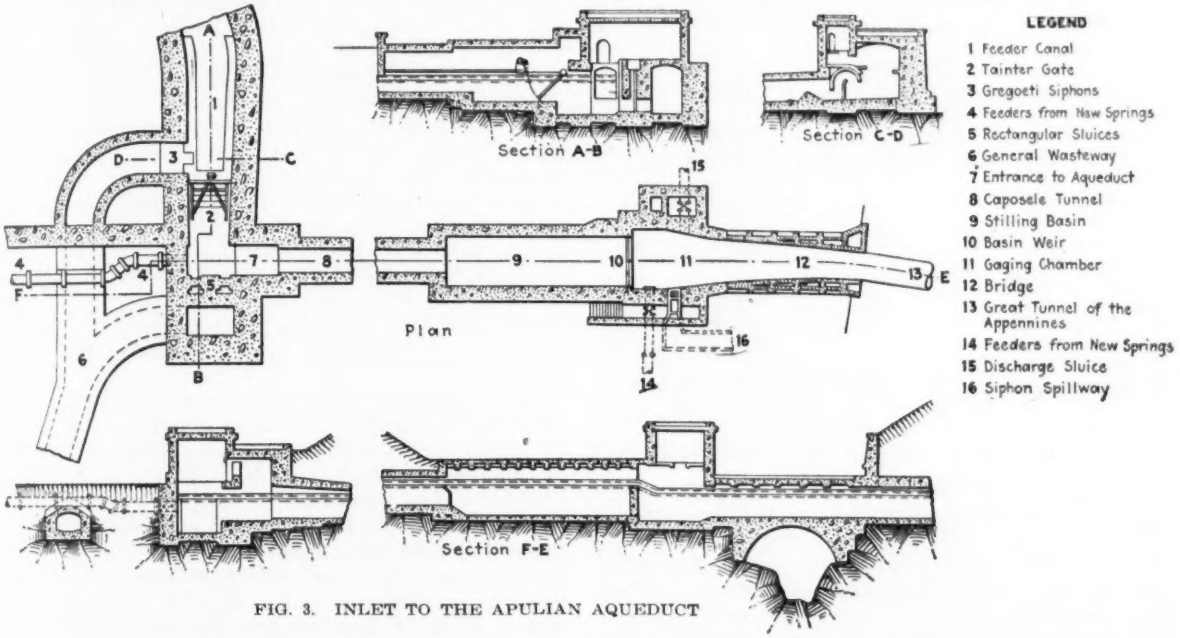


FIG. 3. INLET TO THE APULIAN AQUEDUCT

The Caposele Springs and the Aqueduct Headworks—The Caposele Springs, which feed the Apulian Aqueduct, belong to a group whose combined yield is estimated at about 500 m.g.d. They crop out at El. 1,378 ft. along the contact of a fracture calcareous formation with an underlying impervious belt. This calcareous mountain group, which is the catchment area of these springs, is 233 sq. miles in extent and reaches El. 3,400 ft. The annual rainfall of the area is from 55 to 88 in., of which only 10 per cent falls in the summer.

The yield of the Caposele Springs alone varies from 82.5 to 136 m.g.d. The maximum yield, which occurs in summer, may exceed the winter minimum of the same year by 40 to 45 per cent. The present requirements of the territory served are much lower than the minimum yield. The springs can be easily developed to yield, at their minimum stage, the 137 m.g.d. which is the maximum capacity of the aqueduct, plus the 11.4 m.g.d. which were reserved by the water users below the springs.

The quality of the spring water is excellent: Chlorine from 0.0355 to 0.071 per 100,000; organic matter absorbed by oxygen, 0.0024; and only traces of nitrogen compounds; hardness, 14 degrees on the French scale, or about 9.8 on the English; temperature, usually around 49 deg. F.; bacterial content from 22 to 41 per c.c., of which 5 per cent may be of the liquefying varieties.

The springs were intercepted—"captured"—in the following manner: About a dozen tapping galleries, abutting in the rock at the points of richest water-outcrop, empty into a common collecting channel which curves into a feeder canal, conveying the water into the intake of the aqueduct. (Fig. 2.)

The tapping galleries are of varying lengths and have a uniform rectangular section of 2 ft. 7½ in. x 3 ft. 11 in. Their bottom is of unlined natural rock. The side walls are of concrete blocks whose vertical sides do not touch but are about 6 in. apart. Concrete slabs simply resting on the sidewalls form the roofs of these galleries.

The collecting channel, which is approximately normal in direction to the galleries, is 180 ft. long and 9 ft. 9½ in. wide at its upper end and 16 ft. 5 in. at its lower end. A canal heads near the upper end of the collector and diverts water to the community of Caposele. The bottom of the collector is on a grade of 0.5 per cent and has a concrete lining 20 in. thick. The two sidewalls consist of two series of pillars and arches of masonry, forming two arcades running along the general direction of the channel. The arch panels are filled out with concrete blocks forming porous walls similar to those of the tapping galleries. The arch spandrels are filled with masonry, and a concrete slab roofs the channel.

The excavation in the rear of the sidewalls of the tapping galleries and the collecting channel has been backfilled with coarse rubble which allows infiltration from the surrounding water-bearing strata. The galleries and the collector are covered with a heavy layer of tamped earth.

The collecting channel merges into a feeder canal which has impervious masonry walls and is 56 ft. long and 16 ft. 5 in. wide at its upper end, 13 ft. 1 in. at

its lower end. (Fig. 2.) Its grade is also 0.5 per cent. In the right wall, near the lower end of the feeder, there is a Gregotti siphon spillway discharging into a bypass wasteway. (Fig. 3.) Near the same point, there is a Tainter gate, across the feeder; and close to it there is the abutment of a low masonry dam (7 ft. high) which extends into the underlying impervious strata to cut off any seepage from the springs area into the river bed below. Below the Tainter gate the bottom of the canal is depressed and the inlet to the aqueduct begins at a right angle to the feeder canal. The aqueduct inlet consists of a succession of chambers, a tunnel passage, and a stilling basin having a Bazin measuring weir at its end. At the upper end of the aqueduct inlet, in the wall opposite the Tainter gate there are two short galleries, controlled with sluice-gates, which may be used to divert the flow into a chamber opening

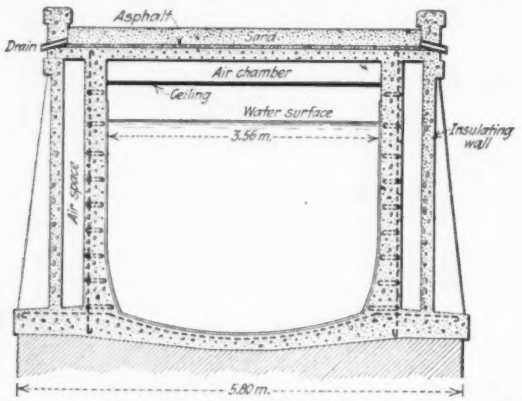


FIG. 4—AQUEDUCT ON REINFORCED-CONCRETE BRIDGE

out into the already mentioned bypass wasteway. Near the lower end of the aqueduct inlet, a little below the Bazin weir, there is a siphonic spillway, in the sidewall of the channel; and also a superstructure, housing various gages and water measuring apparatus. Hence the channel is carried on an arch bridge across a stream bed and finally enters the Great Tunnel of the Appennines.

All of this collecting and intaking system is under a covering of earth. The ground around it was converted into a park which is walled and guarded. The mountainous territory above the springs was expropriated and all cultivation and grazing on it are prohibited. About 5,000 acres situated near the springs are planted with pines. To prevent devastating "avalanches," the extensive slipping formations in the neighborhood of the springs were solidified by drains and retaining walls.

Tunnels—The main trunk of the aqueduct comprises 99 grade tunnels having a total length of almost 67 miles. In the judgment of the designers of the system tunnels are best suited to resist earthquake shocks; therefore tunnel sections were often used even where other forms of construction might have been adopted. Grade tunnels were preferred to pressure tunnels on account of less seepage losses and easier construction and maintenance. The tunnel sections were designed on the basis of the new Bazin formula:

$$V = \frac{87\sqrt{RI}}{1 + \gamma\sqrt{R}}\,;\ \gamma = 0.11 \text{ (metric system)}$$

The velocities allowed range from 1 to 4 ft. per second, the grades from 0.025 to 0.040 per cent. In the most unstable formations the circular cross section was adopted; in more solid formations, the horseshoe; in firm rock, the inverted U section. All the tunnels are lined; most of them with a 1:2:3¼ concrete, and the others with brick in cement mortar. Local limestone crushed and ground furnished the rock and the artificial sand for concrete.

The following are the longest tunnels of the system: The Great Tunnel of the Appennines, Croce del Monaco-Ginestra, and Murge.

The Great Tunnel of the Appennines is 50,055 ft. long or more than twice the length of the Walkill pressure tunnel of the Catskill system. It is curved in alignment and its grade is 0.025 per cent. Its cross-sectional area is about 75 sq.ft. Throughout most of its length a horseshoe section, 8 ft. 9 in. wide by 9 ft. 5 in. high, was used but for swelling clay formations a 9¼-ft. circular section was adopted. The tunnel lining varies in thickness from 15 to 32 inches.

About 28,500 ft. of the length of the tunnel is in a very treacherous formation, an eocenic slaty clay, the very worst formation which may be encountered in Italy. It required unusually heavy timbering. When exposed to heat and damp air it swells and disintegrates in a short time. In tunneling through this formation only electric power could be used; steam locomotives and gas engines were excluded. It was also essential to have most liberal ventilation facilities, and the brick lining had to follow very closely after the excavation. Other serious difficulties were copious seepage, inflammable gases (grisou), and a large mud pocket—the site of an ancient submerged ravine, which had to be outflanked.

Excavation was done by hand, except that compressed air drills and hammers were used in rock. About 0.5 lb. of dynamite to the cubic yard was used for blasting in brittle conglomerate, and from 2 to 3¼ lb. per cubic yard in sandstone and marly limestone formations. Intermediate quantities of dynamite were used in formations of intermediate hardness. These quantities are quite low in comparison with American practice. (In blasting the limestone of the Rondout tunnel, Catskill system, 4½ lb. of dynamite per cubic yard were used.) Muck was removed by means of 25-hp. electric locomotives.

Tunneling was carried on from both ends and from a shaft, 11½ ft. in diameter, 207 ft. deep, located about 33,620 ft. from the upstream portal. Near the shaft there was opened a service chute, 623 ft. long, on an incline of 24 deg., and also a ventilation shaft, 4 ft. in diameter, 151 ft. deep. Another chute, 490 ft. long, on an incline of 35 deg. was opened at about 6,720 ft. from the upstream portal and was used principally for the discharge of muck.

The Croce del Monaco-Ginestra tunnel is 51,948 ft. long. Its first or Croce Del Monaco half is on a grade of 0.025 per cent and has a horseshoe section 75.35 sq.ft. in area, 8 ft. 9 in. by 9 ft. 5 in. The Ginestra half is on a grade of 0.040 per cent and has a horseshoe section 8 ft. 4 in. by 8 ft. 5 in., 64.6 sq.ft. in area. Most of the formations encountered consisted of a pliocenic blue clay and strata of miocene sandstone and marl.

Enormous difficulties impeded the progress of this tunnel. Fully 8,530 ft. of its length, measured from the upstream portal, had to be entirely abandoned on account of excessive seepage, and a vast pocket of quicksand. At the end of the first third, from upstream, the combustion of copious exhalations of "grisou" raised the temperature to 154 deg. F. and work had to be stopped for about two months. At about 1,600 ft. from

the downstream portal, extraordinary exhalations of sulphuretted hydrogen caused asphyxiation and fainting among the laborers and made work well nigh impossible. With the aid of exceptional means of ventilation, this little stretch, only 335 ft. in length, was put through after ten months of work. The shifts were very short.

The tunnel lining varies in thickness from 16 to 21 in.

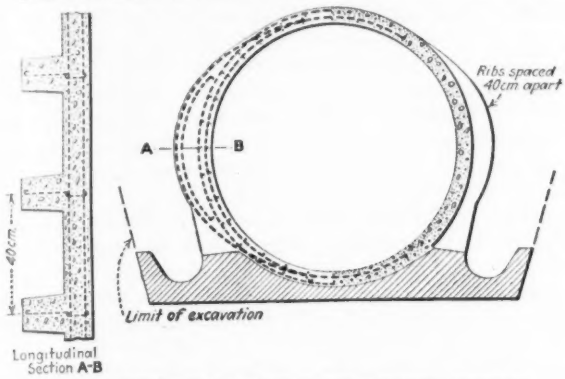


FIG. 5. REINFORCED-CONCRETE RIBBED SIPHON
Shell 4 in. thick, with crescent-shaped ribs spaced 16 in. apart, the latter designed to take care of important secondary stresses.

Various types were used: concrete; masonry of brick, rubble, or travertine (a white spongy marble). Excavation proceeded from the two portals and from two intermediate shafts.

The Murge Tunnel is the longest of all, having a length of 52,562 ft., or about twice the length of the Elizabeth Tunnel, the longest one on the Los Angeles Aqueduct. It is on the main trunk, downstream of the Foggia branch; therefore it has a reduced capacity of only 176.6 sec.-ft., or 108.7 m.g.d. It is on a grade of 0.040 per cent and its cross-section is a flat-bottom inverted U about 52 sq.ft. in area, 6 ft. 9 in. by 8 ft. 6 in. It is practically all in a uniform formation of fractured cretaceous limestone of medium hardness. Excavation was done with pneumatic hammers; there was no seepage; timbering was unnecessary. In general, there were no special difficulties with the exception of a cave, 90 ft. long, which necessitated a detour of 330 ft. Excavation proceeded from the two portals and from five intermediate shafts, one of which was 630 ft. deep.

TABLE II. NOTABLE SIPHONS ON THE APULIAN AQUEDUCT SYSTEM

Name	Length, Ft.	Head, Ft.	Diameter, Ft.	Loss of Capacity, Head, Ft.	Sec.-Ft'
Venosa (steel)	2,294	138	5.25	5.9	159
Locone (steel)	3,570	184	4.9	4.9	159
Palazzo S. Gervasio (reinforced concrete)	14,308	79	5.4	5.9	162
Ofanto (steel)	19,243	528	2.3	100.9	45.5

The tunnel is lined with concrete throughout.

Cut-and-Cover Sections—Below the Murge Tunnel, the main trunk is largely in a cut-and-cover canal, a horseshoe or inverted U in cross section. There are 76 miles of this type of channel in the main trunk. The masonry conduit is either entirely sunk in a trench or it is built along a hillside bench. The abutment walls of the horseshoe sections vary in thickness from 1 to 4 ft. To maintain a low water temperature, the top of the conduit is ballasted with a layer of selected material, not less than 6½ ft. in thickness.

Aqueduct Bridges—Ravines and stream beds are crossed preferably by means of aqueduct bridges ("ponti canali") which carry the aqueduct stream on a slope of 0.050 per cent. There are 93 bridges totaling 4.25 miles in length, in the main trunk. Where good stone was available, the bridges were built as masonry arches supported on massive ashlar-faced piers founded on solid rock. The most remarkable of these are the bridges crossing the Bradano and the Atella Creeks. The Bradano bridge comprises 14 arches of 39.4 ft. clear span each, and has a maximum height of 105 ft. and a total length of 690 ft. The Atella bridge consists of 32 arches of 32.8 ft. clear span each and one arch of 65.6 ft. clear span. Its maximum height is 75.5 ft.; its total length is 1,368 feet.

To prevent rise in the temperature of the water, the conduit is made structurally independent of the bridges: it is set between the bridge parapets and is insulated by means of air spaces, walls of hollow bricks laid on their sides, and layers of asphalt. (Fig. 4.) The conduits are covered with slabs surcharged with a heavy ballast of earth and gravel. The bridges are made wide enough to accommodate maintenance traffic. A wind pressure of some 50 lb. per square foot is taken care of in the design.

Siphons were employed only where bridges would have cost much more. (See Table II for details of the most notable siphons.) It was desired to have a minimum number of siphons and not more than 98.4 ft. (30 meters) hydrostatic pressure in them. The siphons all consist of a double conduit, twin pipes of reinforced concrete or riveted steel. Of the available operating head, 0.66 ft. was usually allowed for various minor losses and the remainder for friction losses. The interior is coated with a rich cement mortar. The diameters were designed on the basis of the formula:

$$\text{Diameter} = D = \sqrt[5]{\frac{B\,L\,Q^2}{Y}}, \text{ in which}$$

L = length in meters; Q = discharge in cub. meters per sec.; Y = friction head in meters; B = a coefficient varying with the diameter.

A siphon over 70 miles long has been designed for the Lecce branch of the aqueduct. The Ofanto Siphon has not yet been constructed. To diminish the hydrostatic head, this siphon will be carried on a reinforced-concrete bridge on seven arches of 82 ft. clear span each.

The siphon crossing the plain of Palazzo San Gervasio is unique in its design. (Fig. 5.) It is of a uniform thickness of 4 in. throughout its length and has corrugated sides. The corrugations consist of crescent-shaped ribs spaced 16 in. apart and projecting out about 6 in. at their middle points. These ribs taper in thickness from 5 in. at the surface of the siphon pipe to about 4 in. at a distance of 6 in. from it. A portion of the reinforcing hoops is imbedded in the ribs close to their outward surface. These ribs have been designed to take care of important secondary stresses which, when occurring in pipes of large diameter, will displace the tension curve to a considerable distance from the center of the pipe shell. The design is due to Prof. C. Guidi of the Torino Polytechnic College.

The siphon pipes have no contraction joints. They were poured in winter; when set they would be filled with aqueduct water and the water held in them until the concrete became as cool as the water. Then the siphon would be drained and any cracks which might be found would be carefully filled with cement mortar,

the soft mortar patch being held in position by means of wire netting until it set and became hard.

Pressure Conduits of Reinforced Concrete and "Eternit"—The main branches conveying water to Bari, Lecce and other districts consist very largely of reinforced-concrete pipes ranging in diameter from 6 to 32 in. and able to withstand hydrostatic pressures of 98 ft. In cases of higher pressures or smaller diameters metallic pipes were used. Some of these pipe lines have a capacity of 42 sec.-ft.

Most of the reinforced-concrete pipes were made by a centrifugal method which has been quite popular in Australia and South Africa as well as in Italy. The concrete is fed into a rotating single-wall steel cylinder, of proper diameter, which contains the reinforcement of the pipe to be turned out. The centrifugal force generated by the rotation of the cylinder automatically

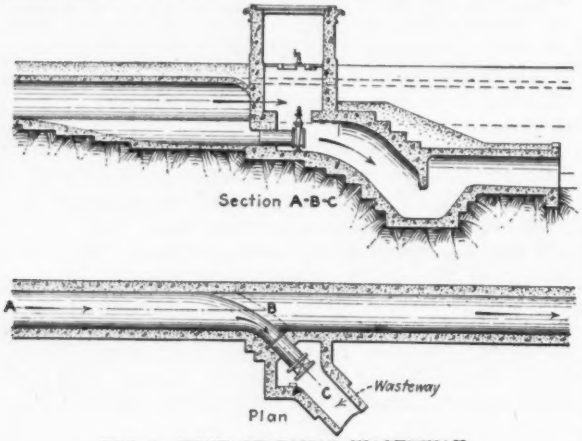


FIG. 6. TYPE OF CANAL WASTEWAY
These are placed every 6 or 7 miles and are generally pipes some 30 to 44 in. in diameter.

distributes the concrete and produces a pipe shell of uniform thickness. An interior coating of asphalt, ⅛ in. thick, is applied by the same method. This coating makes the pipes impervious to heads as high as 200 ft. The reinforcement usually consists of helical wires crossing each other and forming a cylindrical shell of rhomboidal mesh. The pipes are manufactured in standard lengths of 9.8 ft. (3 meters). They are left in the cylinders, in which they were revolved, for 24 hours, after which they are kept wet for 48 hours and then are buried in gravel for 15 to 20 days. After they have been dug out from the gravel, they are kept in a shaded place for one or two months. "They ring like bells" at the end of this period.

In difficult, isolated regions, pipes of "Eternit" have been used. "Eternit"—a concrete made of asbestos fiber and portland cement—is remarkable for its lightness, hardness, strength, and imperviousness. It may have a compressive strength af 12,000 to 14,000 lb. per square inch and a tensile strength of 1,400-2,000 lb. per square inch. Pipes of Eternit are impervious to heads of 400 ft. The Apulian Aqueduct has an Eternit pipe line near Locorotondo, which is 6 in. in diameter, 4,920 ft. long and bears a hydrostatic head of 130 ft. There is also one of the Brindisi line, 12 in. in diameter, 4,265 ft. long, with a hydrostatic head of 130 ft. Eternit pipes have given complete satisfaction on these lines. Promising experiments of great importance were made on the use of Eternit pipes of small diameter for distribution lines. These pipes can be sawed, turned, perforated and riveted and it is very likely that they may be adapted for use on service lines.

Several types of joints for concrete pipes were tried and used. The collar joint has been found to be the simplest and most efficient one, and has therefore been most extensively employed. The exterior surface of the pipe ends is roughened and washed, and the ends are simply cemented together. A strip of wire mesh about 8 in. wide is tied around the joint, and a collar of 1:1 cement mortar, one-half the thickness of the joined pipe shells, is built around it. The lower portion of the collar is incorporated in the cradle on which the pipe rests.

Advantage has been taken of the topography to provide also canal wasteways for every six or seven miles of line. (Fig. 6.) A wasteway of this sort usually consists of a pipe, 30 to 44 in. in diameter, which heads in a depression sunk below the grade of the channel bed and leads out into a ravine or natural channel of some sort. This pipe is controlled by a sluice gate at its lower end. With an operating head of some 10 ft. it is capable of carrying off the flow of the conduit. Manholes are located about 1,500 ft. apart along the aqueduct line. The distribution net has been designed on the basis of a peak factor equal to two and one-half times the normal demand.

Rates, Cost, Administration—The water rates vary from 15 to 35 centesimi per cubic meter, which at par rates of exchange would mean about 11 to 26c. per 1,000 gal., or 8 to 19c. per 100 cu.ft. The rates for irrigation and industrial uses range from about 6 to 9c. per 1,000 gal., or 4½ to 7c. per 100 cubic foot.

At the time of its inception the estimated cost of the project was 136,000,000 lire, which is about $27,000,000 at par exchange. The construction firm to which the concession was awarded received 100,000,000 lire from the Italian government, and 25,000,000 lire from a consortium of the provinces of Bari, Foggia and Lecce. The concessionaire had the right to exploit the system for 90 years from the time of the completion of the principal aqueduct lines, but the Italian government reserved the option of taking over the system within the first thirty years of its operation, provided the concessionaire is duly compensated. The government availed itself of this option and on April 15, 1919, the entire completed portion of the system was taken over by an autonomous board which includes representatives of the interested provinces and is financed by the Italian government. This board will operate the system and will complete its construction. The board is also laying plans for an extensive sewerage system for the towns of Apulia, and agricultural irrigation works.

Engineers—The eminent Italian engineers Zampari, M. Maglietta, G. B. Bruno and I. Maganzini are responsible for the general planning and construction of this system which was first conceived of by Adjutant Rosalba. The construction of the great tunnels was under the successive supervision of Brandau, the builder of the Simplon tunnel, Gianafranceschi, and Bazzochi. Muzzani was in charge of the Great Tunnel of the Appennines, while Meocolombo was in charge of the Murge tunnel. Maselli acted as chief hydraulic engineer. Professors C. Guidi of Torino and G. Fantoli of Milan acted as consulting engineers, particularly on the design of the pressure lines of large diameter. Lack of space will not allow the mentioning of a number of other eminent Italian engineers and administrators who contributed to this achievement of Italian genius.

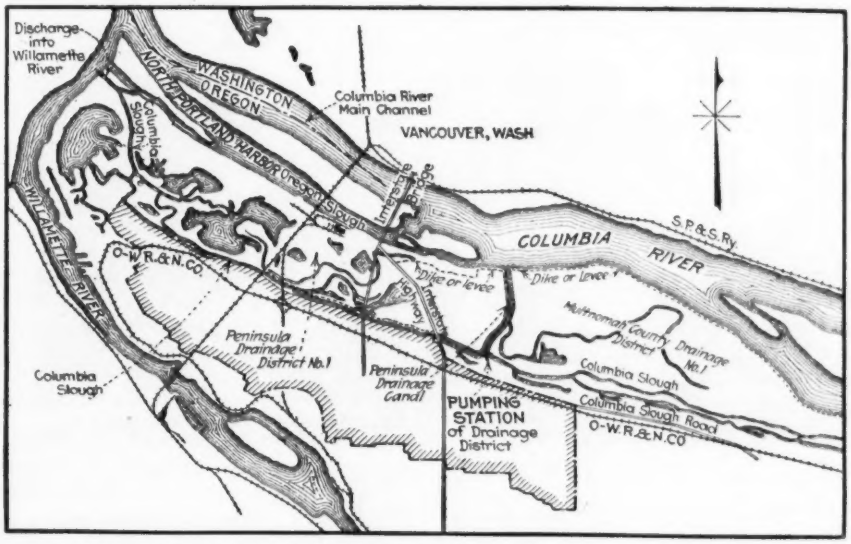
Drainage Project on the Columbia Adjoining Portland, Ore.

Levees and Pumping Plant with Three Types of Motor-Driven Pumps—New Sluice Gate —Design—Assessment System

By W. P. Hardesty
Civil Engineer, Portland, Ore.

A ZONE ASSESSMENT plan, balanced sluice gates or flood gates and motor-driven chain-pumps for low lifts are features of interest in the drainage and reclamation of 8,478 acres of low land along the Columbia River in Oregon by Multnomah County Drainage District No. 1. This district is adjacent to the city limits of Portland, Ore., and extends east for about eleven miles from the interstate highway connecting that city with Vancouver, Wash. It is bounded by the higher ground south of the river and has a maximum width of about 1¾ miles. The appraised valuation of the land is nearly $3,000,000.

Levees—An 11-mile levee along the river front is set back 50 to 100 ft. from the bank in order to be protected from erosion by the fringe of willows and cottonwood trees. The east end of the district is closed by a short levee. The west end is closed partly by the embankment of the interstate highway and partly by a dike built by the city in connection with the outlet of a sewer district. The main levee has a top width of 10 ft. with side slopes of 1 on 2 for ordinary soil, but 1 on 3 is used with sandy material and when the height exceeds 8 ft. Where the borrowpit is on the inside of the levee a banquette of 1 on 5 was formed. Most of the work was done with teams and scrapers but dragline excavators were used for about 1¼ miles at the lower end. Before placing the fill the site was cleared, grubbed and plowed in the usual way. The top elevation of the levee corresponds with a gage height of 30 ft. in the river at Portland. The slope of the water surface at different stages was determined by a series of levels and the grade of the levee was thus fixed to allow a clearance or freeboard of 2 ft. for a stage of 28 ft. on the Portland gage, with allowance for increased height due to the restriction of the channel by the levee. This 28-ft. elevation is practically the highest flood stage except that in 1894 the record was 5 ft. higher.



COLUMBIA SLOUGH IMPROVEMENT FOR SEWAGE AND LAND DRAINAGE

The area inclosed by hatching is the portion of Portland, Ore., for which the enlarged slough affords sewage disposal by dilution. Multnomah County Drainage District No. 1, the westerly end of which is shown on the map, has its surface drainage pumped into an enlarged connection between the Columbia River and the Columbia Slough, shown on the map as "Peninsula Drainage Canal."

Drainage and Pumping—For the removal of interior water due to seepage and rainfall and for the drainage of some shallow lakes and sloughs there is a system of main and lateral ditches connecting with natural channels. This drainage system leads to a concrete dam and pumping station at the lower end of the district. For natural or gravity discharge through the dam there are five sluices of 25 sq.ft. area. Pumping depends mainly on the stage of the river, but at low stages it is influenced by the tide, although the district is 100 miles from the ocean. In operating the pumps the water level in the channels is to be kept well below that required for drainage of the land. Such seepage as occurs is through the natural ground beneath the levee.

Near the east end of the district is a fine lake, called Blue Lake. Since Blue Lake is too deep for drainage, two dams have been built to maintain it at a certain level. Each is an earth dam backed by a wide sand slope, as the rotten volcanic sandstone formation is unsuitable to carry any concrete structure.

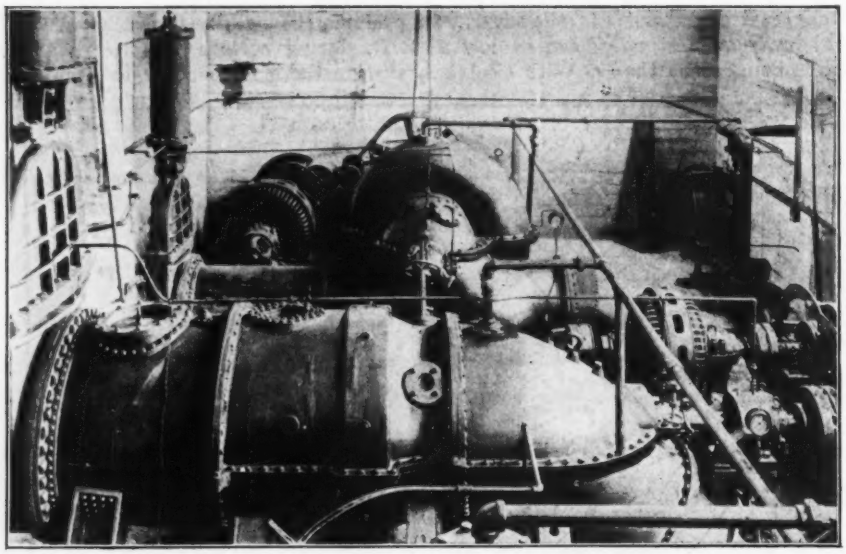
When all the land is under cultivation the district authorities will be required to keep the water down to a level corresponding to a gage height of about 3 ft. in the river. In practice the water is usually drawn down as low as 2 ft. during certain pumping hours.

With electric operation there is economy in running the pumps at full capacity in order to shorten the pumping period and to limit it to night service. The latter is important because the night rate for electric current is only 5½ mills per kw.-hour, while the day rate is 12½ mills. These low rates are granted because of the use of synchronous motors and because of running during off-peak periods. In this way it is economical to lower the intake side far below the required level during the night and allow the channels to fill during the day.

Three pumps are provided. For the lower lifts there is a screw pump with capacity of 50,000 gal. per minute, having a 7-ft. lift and driven at 230 r.p.m. by a 150-hp. motor. This pump has a 48-in. discharge end and can be worked efficiently up to 12-ft. lift. For the higher lifts there are two centrifugal pumps, each with a capacity of 35,000 gal. per minute under a lift of 22 ft. and working at 350 r.p.m., each driven by a 250-hp. motor. These pumps have 36-in. discharge ends and are worked up to a 26-ft. head when required by changing belts and by using a smaller pump-shaft pulley. The screw pump is more economical for the

ordinary stages of the river, but as a rule all the pumps are used on account of the economy in pumping only at night. During a few weeks of the average year pumping against a head of 15 to 25 ft. is required. Two of the pumps are shown in the photograph.

Chain Pumps for Low Lift—An interesting practical problem developed with reference to pumping during the low-water season, since for about half the year only three low areas (lake beds) require the aid of pumping and these form but a small part of the total area. A chain-lift type of pump or water-elevator has been designed for use with the low lift required, 4 to 6 ft. Each of these elevators will be automatically



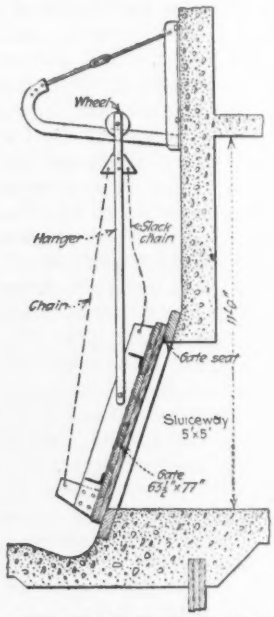
SCREW AND CENTRIFUGAL DRAINAGE PUMPS

controlled by means of float-switches so as to require only occasional visits from the attendant, and the power required for each will not exceed 15 hp.

These water elevators will discharge into the main drainage ditch, in which the connections with other drains will be temporarily closed. As this channel will carry water up to a height of approximately 10 ft. on the river gage before overflowing its banks, the water will be carried to the pumping station and there afforded an abundant outfall head for gravity discharge into the city outlet drainage channel. By this arrangement the pumping station may be shut down for a longer period during the year. An advantage of the chain-lift type of pump over the ordinary type for such low heads is in obviating the loss in velocity head and in entry through the foot-valve, which in such circumstances amount to a large proportion of the total load.

Balanced Flood Gates—For the sluiceways at the pumping station flap valves of a new type are used to permit outflow from the drained area but to shut off inflow. The construction is shown in the drawing. Both sluiceways and valves are rectangular. The latter are of wood with steel frames and close against wood seats set in the concrete of the sluiceways. The seats are inclined so that the weight of the valve aids in making a tight closure, especially when the water fills only part of the sluiceway. Each valve is suspended from a trolley rail at each side by a hanger or arm 8 ft. long. The arms are attached slightly above the middle of the valve and are pin-connected at both ends, the upper end being attached to a grooved wheel. Less than one inch difference in head serves to open the valve, and as it moves far out when opened and is entirely clear of the sluiceway there is no chance for small sticks that pass the trash screens to collect and prevent tight closing. This arrangement also permits a full flow from the sluiceway with an insignificant loss of head.

The trolley wheels have a travel of about 2 ft. and both the wheels and rails are kept well greased. Two chains attached to the top of each hanger



BALANCED SLUICE GATE IN DAM

have their lower ends attached to the top and bottom of the valve frame, as shown. The latter serves to hold the valve at the angle provided by the seat, and the bottom of the valve is counterweighted to insure prompt return to this position. The top chain is slack with the valve in closed position and its only purpose is to prevent somersaulting of the valve with a strong current when the sluiceway is open. The trolley-rails are adjustable as to slope or grade by means of turnbuckles in the diagonal suspension rods supporting their outer ends, thus securing the position for quickest response to pressure on either side of the valve.

Cost and Assessment—The total cost of construction work will be about $550,000. This represents about $65 per acre for the total area, $76 per acre for land in "Zone 1" (100 per cent benefited) in the main district and $114 in a sub-district. That part of the district nearest the city has a potential future value for industrial sites, but only reclamation for farming purposes is at present proposed. Under the Oregon drainage district law the costs of reclamation are met by bond issues which become a direct lien on the land within the district. Interest and principal are met by taxes levied and collected by county officials in the same manner as ordinary taxes.

A zone system was devised in working out a basis for equitable assessment of the land to be benefited. Accurate contour maps were available and river records showed that flood heights up to or near 20 ft. gage could

be expected in most years. Floods up to 24 ft. have occurred but those above 28 ft. were very exceptional and no attempt at protection above 28 ft. has been made, so that such high land receives no benefit. There are small areas occupied by the slough and drainage channels and also one very deep lake (as mentioned above) where the bed is too low for reclamation.

From the foregoing considerations, the following ratios were adopted to fix assessment rates in respective zones: (1) Areas below 20 ft. gage height (except deep slough and lake beds), 100 per cent; (2) areas between 20 and 24 ft., 80 per cent; (3) areas between 24 and 28 ft., 20 per cent. No assessment is made against areas in deep slough and lake beds or those above the 28-ft. contour. Each holding of land was first classified and the respective areas were scaled on the map, with the area of each zone multiplied by its percentage rate. Then the sums of products for each ownership and for the entire district were worked out. The ratio for each ownership, above or below the average taken as 100 per cent was then obtained. By this method a uniform rate per acre for each ownership was fixed, and this assessment remains in any subsequent transfers, regardless of the zones. The annual tax is made to cover the interest on the bonds, maintenance and pumping, and also to retire serial bonds as they become due.

This drainage and reclamation project was planned and carried out under the supervision of William G. Brown, consulting engineer, Portland, Ore.

Converting Columbia Slough Into Sewage Outlet

Affords Disposal by Dilution for Part of Portland —Slough Enlarged and Dyked—Design—Construction—Channel Flow

By W. P. Hardesty
Civil Engineer, Portland, Ore.

THE greater part of Portland, Ore., lies between the Willamette and Columbia Rivers, and for most of the city the Willamette is the natural outlet for sewers. In the northern portion of the city, however, including most of the district locally known as the "Peninsula," is an area as near to the Columbia as to the Willamette, but still separated from the former by such a wide expanse of bottom lands as to make it very expensive to reach by sewer. A short distance out from the foot-line, and coursing through these bottom lands, is the Columbia Slough, a channel heading in the Columbia River and extending on past the city a distance of 17 miles to its discharge into the Willamette, shortly above the latter's junction with the Columbia. For a number of years the possible utilization of this slough for the discharge of sewage from the area described has been considered. In 1913, very elaborate topographic and hydrographic surveys were made, covering many square miles. The works to be described follow a plan adopted by the city in 1919.

Design—The design consists essentially of an inlet channel from the Columbia River to the Columbia Slough and the improvement of the latter by widening and deepening so that sufficient water may be carried at all stages to dilute the sewage enough to obviate any nuisance. Trunk sewers discharge directly into the channel and slough from moderate-sized districts, taking the shortest routes, and already five of these have been built.

Though Columbia Slough has a connection with Columbia River at medium stages, the supply is so moderate and the slough so deficient in its upper reaches that the idea of using this portion was abandoned. Instead of this an independent inlet is provided, tapping the river directly opposite the city and running about 1¾ miles across the bottoms to a junction with the slough, from which point on the slough is partly improved by deepening and widening. The sewage flows through the slough about eight miles before it reaches the Willamette.

Preliminary studies indicated an area of about 6,000 acres and present population of about 30,000 to be provided for, and an estimated minimum waterflow through the channel of about 450 sec.-ft. This would give an abundant dilution at present and 6 sec.-ft. per 1,000 people when the district population should become 75,000. It is anticipated that a population of 200,000 in the sewer district will eventually be provided for by enlarging Columbia Slough clear through to the Willamette, but for more than this population the entire channel will have to be enlarged.

As a portion of the area served by the drainage channel lies outside the city limits, a special legislation was required to permit assessment of this land to help pay the costs.

The standard cross-section of the channel has a bottom width of 150 ft.; side slopes of excavation, 2 to 1; slopes of dykes alongside, 3 to 1 on the inside and 2 to 1 on the outside, with 10-ft. bermes. One dyke has a top width of 10 ft. and the other of 16 ft., the latter providing for a future roadway. Where the right-of-way is contracted the inside dyke slopes are made 2 to 1 and the bermes are omitted.

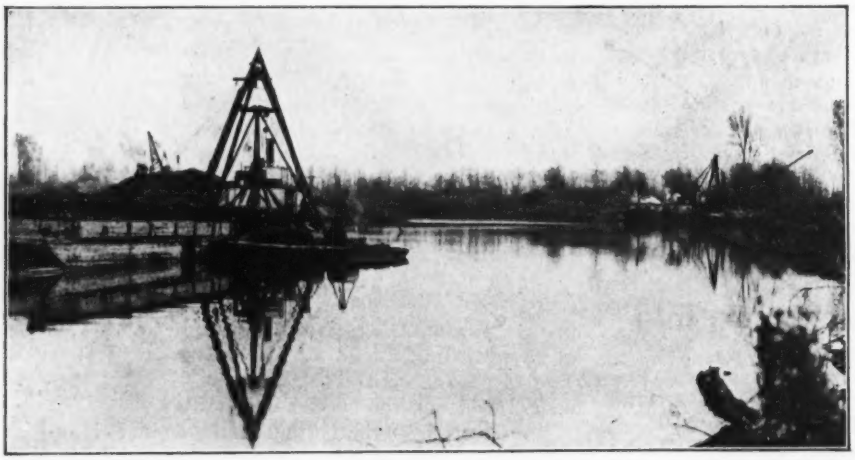
The elevation of the bottom of the channel is —6 by U. S. G. S. datum, or 6 ft. below mean sea level, although the discharge of the Columbia into the ocean is over 100 miles away. This provides a water depth of 7½ ft. at low-water. The elevation of the top of the dyke is 33 ft. (39 ft. above bottom).

In its course from the river inward to connect with Columbia Slough the channel follows McBride's Slough most of the way, to lessen excavation. Columbia Slough itself (running westerly nearly parallel to the river) was deepened and widened down to the Interstate Highway, a further distance of ¾ mile. At different places along the route five tributary sloughs are crossed, so that the dykes in some places are as much as 43 ft. above the slough beds. In its alignment the channel has three curves with radii of 874 to 3,350 ft. To prevent wash, riprap was placed on the outside of the sharper curves as well as for a few hundred feet adjacent to the river entrance and also on the high embankment dykes at the slough crossings. The riprap was brought in on barges and unloaded by means of floating derricks. At the off-take from the river the channel has a slight upward course, but this was not sufficient to prevent entry of floating drift, so a boom was built consisting of four dolphins with a line of sheer boom sticks (logs) on each side which are loosely fastened to the dolphins with chains, so that they raise and lower with the water level. This boom is 240 ft. long, and at its downstream end an opening remains sufficient for entry of barges and boats. Just inside the entrance a pile-trestle provides a road crossing.

This has a 50-ft. movable truss span that can be picked up bodily by a derrick on a barge and set back on the trestle, to permit passage of water-craft.

At the junction with Columbia Slough the slough itself is dammed off on the upper side, and the outlet from it into the channel is provided by means of sluiceways through the pump-house of Multnomah Drainage Dist. No. 1. (See preceding article by Mr. Hardesty in this issue.—EDITOR.)

It may here be stated that the dykes of the channel are not essential to its purpose of dilution and discharge, but were adopted by agreement between the city and this drainage district and one other one, really to protect lands being drained from *overflow* resulting from the new opening from the river. A much shallower section of channel would have been adopted if the lands had not been under reclamation, with bottom grade the same but with no provision of high dykes to prevent overflow from the channel during high water. The dykes after completion were turned over to the drainage district for maintenance.



DREDGING COLUMBIA SLOUGH, TO AFFORD SEWAGE DISPOSAL BY DILUTION
Dredge at left loading onto barge. Loaded barges were towed back and unloaded to form dykes. In right distance, barge being unloaded by clamshell bucket operated by derrick on barge.

The contract for the entire channel improvement was awarded during the winter of 1919-20 to the Pacific Bridge Co. of Portland, and the work was completed in the spring of 1922. The prices were quite low (for inflation times), and the item of 18c. per cubic yard for excavating and depositing material wherever needed made it very difficult for the contractor to break even.

Methods of Construction—The entire area to be covered by dykes was first cleared and grubbed, after which it was ploughed to give a good bond with the embankment. Dredging appliances were used as far as possible, as being cheaper, so work had to start at the river end and progress inward. No fewer than seven different types of excavators were used at different times. The first cut, and also a second where ground was higher than the average, were taken out by a dragline excavator placed on either bank and hoisted over for the dyke.

The big dredge "Titan," with a 4-yd. dipper, was one of the most efficient of the appliances. It loaded onto barges, which were then towed back to where needed and unloaded by clamshell buckets operated by derricks mounted on barges. Clamshell dredges were also used in excavating from the channel and placing directly in the dykes. These dredges had booms 125 ft. long. During low water they were at a disadvantage as, riding so low, the upward angle of the boom (by shortening) made it difficult to deliver to the outside of the dykes. They were much better adapted to high-water, both on account of riding higher (and so allowing a flatter boom angle) and because they could then float in nearer to the dyke and lessen the required reach. For this reason the contractor contrived to use them as much as possible during high-water. These long-boom dredges could also be used to some advantage in excavating ahead and swinging around to discharge to the rear, where the material was more needed in the dykes.

Much trouble was experienced in depositing the dripping wet material from the dredges onto the banks or dykes because of the tendency to flatten out and spread far beyond the proper limits, especially if deposited in great depth at any one time. The plan was then adopted of building in layers, letting each layer drain and partly dry out before placing the next one, and this necessitated moving the dredge back and forth several times before completion. In some other respects, however, the high water was a detriment, as during the June floods of 1921 (the highest since the record of 1894), the dykes were still uncompleted and there was imminent danger of the water breaking through and flooding the reclaimed land, so that constant watchfulness was required.

In the latter part of the work, when the bottom was down near to grade, a suction dredge of the Port of Portland was employed. This was much better adapted to finishing off to true grade than either the clamshell or the dipper dredges, as scoopholes are bound to result with them and it is very difficult to spot and hit accurately the high points in dropping under water. An advantage of this dredge, also, was the ability to discharge material away from the work, and in this way considerable material was used in filling in adjacent slough and lake beds. The greater proportion of the excess excavation on the job was used, however, in widening and raising the dykes. Some of it was barged out of the channel into the river and unloaded onto low land near the shore. Most of the material was a rather stiff clay, with but little sand, and not easily eroded.

Actual Flow in the Channel—Many measurements of the velocity and volume of flow in the channel were made in the two years before its completion. The fall is only about ½ in. per mile. It was ascertained that a value of 0.047 for n in Kutter's formula was correct while the work was still in the rough, but as work progressed and the slopes and bottom were made smoother this value reduced to 0.040. During the high water of 1921, with a depth of 33 ft. in the channel, the velocity reached about 4 ft. per second.

The flow during low water will become of increasing importance as the sewerage district settles up. During low stages the effect of flood tide in the Pacific is to back up and check the flow in the river and channel, while the outgoing tide accelerates the flow. The results so far show a minimum of 223 sec.-ft. when uninfluenced by tides and 97 sec.-ft. with the tide

CONSTRUCTION COST OF COLUMBIA DRAINAGE CHANNEL

Excavation used in embankments, 1,230,583 cu.yd. at $0.18	$221,505
Excavation wasted, 144,005 cu.yd. at $0.18	25,921
Rock excavation, 10 cu.yd. at $5.00	50
Riprap placed, 18,747 cu.yd. at $3.00	56,241
Clearing and grubbing, 43 acres at $200.00	8,600
Plowing under embankment, 49.8 acres at $10.00	498
Extra work	13,389
	$326,204
Right-of-way	23,528
Total	$349,732

Engineering costs not included.

obstructing. The mean velocity seldom falls below 0.5 ft. per sec. except with tide effect. As the sewerage district becomes more populated the remainder of Columbia Slough, reaching seven or eight miles further on to the Willamette, will have to be deepened and widened. This will tend to accelerate the flow in the channel described and prevent unsanitary conditions along the slough. Considerable deposit of sand from the river has occurred along the upper part of the channel during high water, due to the checking of the velocity of water as it enters the channel.

The design of the works described was prepared under the supervision of O. Laurgaard, city engineer. A. J. Wiley, consulting engineer, Boise, Idaho, was employed by the city to pass on the feasibility of the plan proposed. The execution of the work was in immediate charge of R. E. Kremers, chief of the Bureau of Construction, assisted by J. R. Hanson.

Percolation Through and Hydraulic Pressure Under Earth Dams

Discussion and Co-operation of Engineers Solicited to Make Investigation Cover Wide Range of Conditions

By A. L. Fellows

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THE division of agricultural engineering, U. S. Bureau of Public Roads, co-operating with the U. S. Reclamation Service, is undertaking a detailed investigation of the underlying principles involved in the design and construction of earthen dams and embankments designed for the impounding of water for irrigation and other purposes, with a view to securing a larger measure of safety and efficiency in such works. Among the subjects to be investigated are the rates of flow and amounts of water percolating through such dams, the location of planes of saturation with reference to water levels in the reservoirs, the fluctuations of the planes of saturation, the effects of the saturated portion upon the stability of the dam and the need for drainage of the material forming the outer part of the embankment. Also included in the studies are the extent and effects of the hydrostatic pressures beneath dams, the construction, economic advantages and efficiency of core walls of different types upon the planes of saturation within the embankments.

Much of the available data bearing upon the subject has already been compiled and tentative plans for investigations, with specifications for work to be done, directions to observers and forms for records, have been prepared. The plans for making the further studies proposed at this time contemplate the selection of as large a number of earth dams as is practicable. These dams are to be of various types of construction, heights, materials, facings, cores and other details. Some will be selected which have cores of various kinds such as concrete, puddled or selected clay, gravel, etc., and others without cores will be chosen; similarly, dams with different types of facings will be studied.

The investigation may include the sinking of two types of wells in selected cross-sections, the number and locations of the wells depending upon local conditions. Generally speaking, the two types are to alternate in each section. One type will be sunk approximately three-fourths of the depth through the embankment, practically the entire length of the pipe being perforated; these wells should yield data regarding planes of saturation as related to the rise and fall of water in the reservoir. The other types would be sunk to the natural base of the dam, the pipe being open only at the lower end, and would be for the purpose of obtaining information bearing directly upon the hydrostatic pressure or uplifting force. Records of the water levels, both above and below the dams and in each well, are to be kept and regular reports made.

Obviously the most satisfactory results can be obtained only through the widest co-operation in the engineering profession generally. Any engineer having charge of the construction or operation of earth dams, and who realizes the importance of the subject, will doubtless be willing to assist to the best of his ability. With a view of gaining such aid it is proposed that this plan shall be widely published and discussed among those who may be interested, with the object of obtaining co-operation along the following lines:

1. Furnishing information as to any known data bearing upon the subject under consideration.

2. Suggesting dams where such investigations as those proposed may be made to advantage, or should be made with a view to the preservation of the dam.

3. Recommending such investigations to the owners of dams selected or suggested.

4. Requiring such studies to be made whenever the engineer has the authority and thinks it advisable, particularly in connection with the construction of any new dam.

5. Making such suggestions and raising such questions bearing upon the problems involved as may occur to him.

Supervision of the investigations has been delegated to the writer, from whom any further information desired regarding the matter may be obtained.

Water Consumption and Meters at Woonsocket

The per capita water consumption at Woonsocket, R. I., for the year 1921, according to the latest annual report of the Water Department, was 50.7 gal. per consumer and per inhabitant, it being assumed that the entire population of 49,327 on the pipe lines within and outside the city was supplied. Of the total consumption, 79.9 per cent was metered. The percentage of services metered was 98.

Speeding Up Traffic at Street Intersections

Slow Ups and Hold Ups at Intersecting Streets One of the Chief Causes of Automobile Traffic Congestion —Relief Measures Outlined—Traffic Survey a Prerequisite

By Herbert S. Swan
City Planner, New York City
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I. Why Street Intersections Are Congested

THE relative congestion at different street intersections is exceedingly difficult to appraise, not only for the reason that different vehicles obstruct traffic in varying degrees but because their obstructiveness varies within a wide range under different conditions. Were the size, speed and flexibility of vehicles the only factors entering into their obstructiveness to traffic, then each type of vehicle, whether it were an automobile, a truck, a trolley car or a wagon, could be given a

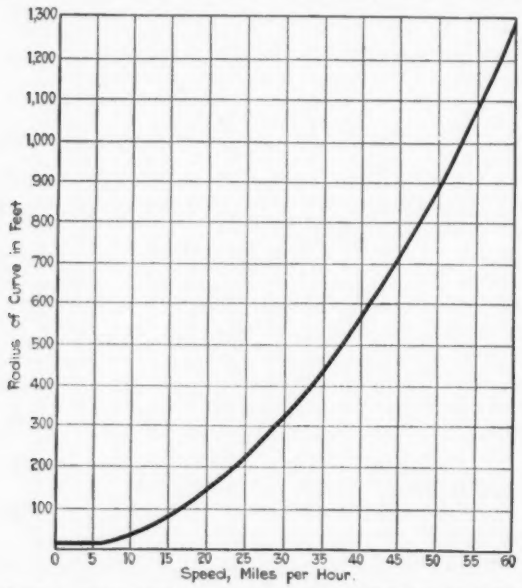


FIG. 1—MAXIMUM AUTOMOBILE SPEEDS ON CURVES

weight in proportion to its obstructing character. This would enable one to compute the volume of traffic in terms of obstructing units, thus reducing the traffic conditions at different street intersections to the same common denominator.

But the problem is far too complex to admit of any such ready solution, for the very same vehicle moving in a different direction or over a different path may either increase or decrease its obstructive character. Obviously, a vehicle paralleling the main line of travel obstructs traffic less than one cutting across it at right angles; a vehicle turning to the right retards movement less than one turning to the left; a vehicle making a slight turn holds back traffic less than one turning through a large angle; a vehicle crossing a narrow street occupies the space within the intersection a shorter time than one crossing a wide street.

Very obviously traffic is obstructed and delayed more at intersections than between intersections: (1) the number of vehicles in intersections exceeds that between intersections; (2) a turning vehicle requires more roadway space than a vehicle moving along a straight line; (3) a turning vehicle must proceed more slowly than a vehicle going directly ahead; (4) numerous conflicting routes are open to traffic at intersections; (5) a vehicle approaching an intersection must, to avoid collision with crossing vehicles, travel more slowly than when between intersections; and (6) cross traffic and through traffic must stop alternately to let the other pass.

1. *Number of Vehicles*—The number of vehicles passing through an intersection is the sum of those arriving from all directions. This is, of course, generally a much larger number than that passing over any of the streets entering the intersection. In the case of two intersecting streets having an equal amount of traffic, the volume within the intersection itself is double that at any point outside the intersection. Where three streets of like traffic intersect, the traffic volume at the intersection is approximately thrice that on any of the individual streets. The more streets that intersect, the greater, as a rule, is the traffic density at the intersection, the exact volume in any particular case varying in direct proportion to the number of intersecting streets where all the intersecting streets have an equal amount of traffic.

2. *Greater Space Required by Turning Vehicles*—A car turning a corner is always harder to keep in position than one moving straight ahead. The car itself, moreover, on account of the relative position of its front and rear wheels occupies more than its normal roadway width, the excess over normal width varying in proportion to the length of the vehicle and the sharpness of the turn. The width of the ordinary automobile is 5 ft. 9 in. Assuming that the body of the machine is 12 ft. long and that it turns on a 21-ft. radius, the width of path required by it in turning is increased to 7½ ft. Neighboring machines must also be taken into consideration; at intersections their path cannot be as acurately gauged and allowed for as between intersections. These factors all demand increased clearance at intersections, a clearance increasing in amount as the curved path diminishes in radius.

3. *Slower Speed of Turning Vehicles*—A turning vehicle must proceed more slowly than one travelling straight ahead. The maximum safe speed around corners depends entirely upon the radius of the turn.

The centrifugal force in turning cannot be allowed to exceed certain well-defined limits or passengers will suffer not only physical discomfort but be imperilled by the possible skidding or overturning of the machine. The outside safe speed with respect to both of these considerations is that in which the car is deflected at right angles from a straight course at the rate of 6 ft. per second per second. This gives rise to a centrifugal force equal to 18 per cent of the weight. A speed not exceeding this amount protects the passenger against an unpleasant nervous sensation. It also provides a factor of safety of about three against skidding on dry asphalt. The safe speed of the machine under these conditions varies as the square root of the radius of the curve in

which it turns. Fig. 1 shows the maximum safe speed around curves according to this rule.

(The formula for ascertaining the safe speed of a car around a corner is $V = 1.67\sqrt{R}$, where V is the speed in miles per hour and R the radius of the curve in feet to the center of the machine.)

The minimum turning radius of the average car as measured along the center line of the machine is 21 ft. The maximum safe speed for that radius is 7.7 miles per hour. Only as the radius exceeds this amount can the traffic turning at intersections safely attain a greater speed. Most cars turn in a radius of from 17 to 27 ft. Most curb radii are, however, only 6 ft. or even less. They rarely exceed 12 ft. The consequence is, of course, that cars in turning corners cannot keep close to the curb.

4. *Conflicting Routes*—Between intersections there are but two ways open to traffic, it must move either one direction or the other, but at intersections it has a choice of several different routes, the exact number varying with the number of roadways entering the intersection. Thus where three roadways enter an intersections there are six separate and distinct routes open to vehicles. Where four roadways enter an intersection the number of routes is increased to twelve; where five roadways enter to twenty. The presence of so many routes which frequently conflict with one another naturally necessitates not only greater caution but slower movement on the part of traffic.

5. *Slower Speed of Crossing Vehicles*—All vehicles upon approaching an intersection, even though they do not turn, must, to avoid collision with vehicles entering from other directions, travel more slowly than when between intersections. It is also often necessary for them to stop to give conflicting traffic the right of way. Vehicles entering an intersection of right-angled streets 40 ft. wide can run only 14.7 miles an hour if they are to stop in time to avoid collision with vehicles approaching the intersection behind obstructing buildings. If the two intersecting streets are 50 ft. wide, the speed may be increased to 17 miles an hour; if 60 ft., to 17.5 miles an hour; and if 80 ft., to 20 miles an hour.

When a vehicle turns at an intersection, even if it does so without any diminution in speed, it does not travel as fast in the direction of its previous course as before turning—and its curved path naturally hinders machines in back of it. When a machine in negotiating a turn slows down, the hindrance to traffic until the traffic line is entirely cleared is, of course, still greater. A turning machine obstructs not only its own traffic line but also all the traffic lines it must cross. If it turns to the right, and it does not happen to be near the curb when it turns, it obstructs all the traffic lines between its own line and the curb; if it turns to the left, and it does not happen to be near the center of the roadway when it turns, it obstructs all the traffic lines between its own line and the center of the roadway as well as the traffic lines on the street moving in a direction opposite to its own.

6. *Alternate Stopping of Cross and Through Traffic*—Vehicles are able to filter through intersections with very little traffic with only occasional stops to avoid conflicting traffic, but as traffic increases, the streets entering an intersection must be opened and closed to traffic alternately or dangerous jams will result. Where the traffic on two intersecting streets of the same width is about equal, each street will be closed approximately one half of the time. Where the traffic on two intersecting streets is equal but the width of one is twice as wide as that of the other, the narrow street will require nearly twice the time of the wide one to pass its traffic. In that case the narrow street will be closed one-third of the time and the wide street two-thirds of the time. The longer a street is closed to traffic, the less traffic will it accommodate.

Table I shows the per cent of time that a narrow street crossing a wide street is open to traffic under different conditions. Quite obviously the acuteness of the traffic problem at intersections varies with the relative width and traffic volumes of the intersecting streets.

The quantities given in the table show the per cent of time required to pass traffic on the narrow street when

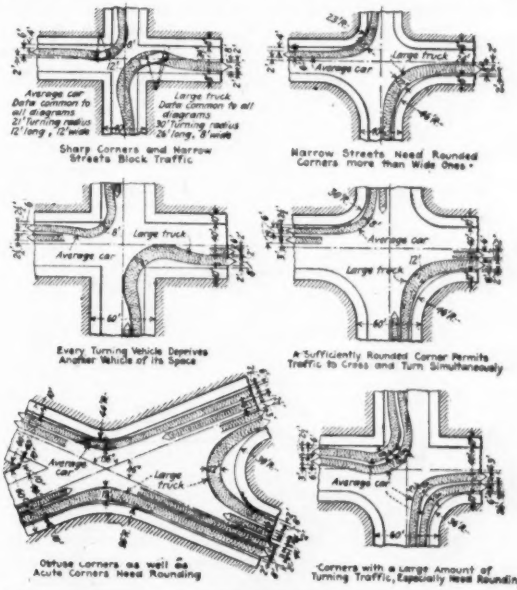

Average car
Large truck
Sharp Corners and Narrow Streets Block Traffic
Narrow Streets Need Rounded Corners more than Wide Ones
Every Turning Vehicle Deprives Another Vehicle of its Space
A Sufficiently Rounded Corner Permits Traffic to Cross and Turn Simultaneously
Obtuse corners as well as Acute Corners Need Rounding
Corners with a Large Amount of Turning Traffic, Especially Need Rounding.

FIG. 2—ROUNDED CORNERS RELIEVE CONGESTION

its traffic and width in proportion to the traffic and width of the wide street are as stated. Thus, for a narrow street, 50 per cent of the width of the wide street, but carrying 200 per cent of the traffic of the wide street, the narrow street would be open 74 per cent of the time and the wide street 26 per cent of the time. If the narrow street is open 44 seconds the wide street would be open 16 seconds. The tabular quantities vary slightly according to the absolute intensity of traffic and the width of streets. Mean values were assumed for these quantities in the computation of the table.

Deceleration upon approaching an intersection means diminished speed upon leaving the intersection; normal speed after leaving the intersection cannot be recovered until sufficient time has elapsed for necessary acceleration. Where intersections occur with great frequency, the intervals between acceleration and deceleration are so brief as not only to effect a considerable reduction in average speed but also in maximum speed. In fact, the maximum speed between intersections, is in many cities on account of the frequent intersections, no greater than and sometimes not as great as the safe speed in approaching intersections.

7. *Right-hand Turns*—The speed at which machines can turn corners depends upon several factors: width of the intersecting streets; whether or not a corner is rounded off and the extent to which it is rounded off:

whether the turn is to the right or to the left; and the distance the machine is travelling from the curb.

How closely a car can keep to the curb and avoid interference with other lines of traffic in turning depends upon its turning radius. A car with a short turning radius can obviously keep nearer the curb and avoid interference with other lines of traffic better than one with a long turning radius. Many machines, especially the bigger one, with large turning radii, experience great difficulty in making right-hand turns without encroaching upon the left-hand side of the roadway. Particularly on the narrower streets it is no uncommon occurrence for machines to swing almost over to the left-hand side before turning to the right. Sometimes this swing to the left is carried out within the intersection itself in a manner to block the intersection from all

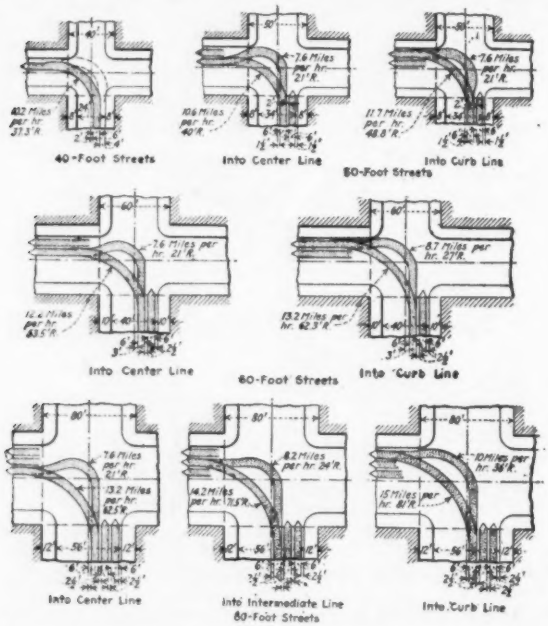


FIG. 3—LEFT-HAND TURNS AT STREET INTERSECTIONS

directions. Right-hand turns executed in this manner are more embarrassing to traffic than those to the left. The vehicle unit nearest the curb can turn to the right about equally well on all streets, irrespective of width—the greater clearance on the narrower streets balances the greater curb radius on the wider streets.

So far as right-hand turns are concerned, increased street widths serve to increase the speed of turning cars only as they turn near the center of the roadway. To avoid interference with other lines of traffic, however, they should turn as near to the curb as practicable. With curbs rounded by a radius equal to the least sidewalk width cars can generally make the turn without encroaching on other traffic lines, but the margin of clearance is quite small. The safe speed of the traffic unit next to the curb in turning is about eight miles an hour, that of the second traffic unit from the curb nine miles, and that of the third traffic unit from the curb ten miles.

Fig. 4 shows the vehicular paths taken by right-hand turns at intersections on the assumption (1) that machines maintain the same clearance around the turn as they do upon the main highway stem, and (2) that they make the sharpest turn possible within their turning radius but in such a manner as not to transgress the centers of the two intersecting streets unless absolutely necessary. The first column of diagrams to the left shows the vehicular paths with unrounded curbs; the second from the left, curbs rounded with a radius of 6 ft.; the third from the left, curbs rounded with a radius equal to the least sidewalk width; and the fourth from the left, curbs rounded with a 20-ft. radius.

8. *Left-hand turns*—In making a left-hand turn a car travelling near the curb has the greatest turning radius. It can, therefore, move with greater speed than a car near the center of the roadway but its longer path more than offsets its increased speed.

When a car, in making a left-hand turn, has to go around a central point, turning radii and safe speeds on streets of different widths are the same as with turns to the right around a sharp corner. Left-hand turns around a central standard are in fact sharper and more difficult to negotiate than right-hand turns around rounded curbs.

On a 40-ft. street, a machine cannot make a left-hand turn without venturing on the opposite side of the roadway. In the case of a 60-ft. street only one of the two traffic units accommodated can turn to the left; either the inside unit must halt while the outside unit turns, or the outside unit must come to a standstill while the inside unit turns—there isn't sufficient room for both of the units to turn at the same time. On 80-ft. streets only two of the three traffic units can turn at the same time.

Fig. 3 shows the vehicular paths taken by the center traffic line on streets of different widths when it transgresses not at all or as little as possible the space and clearances reserved for other traffic lines moving in the same direction. One path is shown with the maximum radius possible under the above conditions when the vehicle passes around a standard in the center of the intersection; the other path is shown with the maximum radius possible, also subject to the above conditions when the vehicle passes around standards in the center of the street upon entering and leaving the intersection but with the privilege of cutting across the center of the intersection itself. When a street has room for two or more traffic lines, the turning vehicle, though always shown in the center traffic line upon approaching the intersection, is shown after having completed the turn as leaving by each of the respective traffic lines.

II. How to Relieve Congestion at Intersections

Relief to intersections may be afforded in various ways:

1. Curb corners may be rounded off with greater radii.
2. Corners may be cut off and additional land included within intersections.
3. Building lines may be established to keep buildings back of street lines.
4. Streets may be splayed out near intersections.
5. Vehicular paths around corners may be marked upon pavements.
6. Parking may be prohibited near intersections.
7. Standards may be erected to guide traffic.
8. Traffic may be re-routed.
9. One-way streets may be established and left-hand turns prohibited.
10. Cross streets may be opened and closed synchronously.
11. Fast and slow traffic may be separated.
12. Grades of intersecting streets may be separated.

1. *Rounded Curbs*—A rounding off of curb corners with greater radii not only facilitates the movement of turning vehicles but increases their safe speed around corners. So far as the convenience of traffic is concerned the curb should be turned with a radius that will permit a car with the maximum turning radius to follow the curb. To employ such a large curb radius would, however, require the taking of property at street

TABLE I—RELATIVE TRAFFIC INTERVALS AT STREET INTERSECTIONS

Width of Narrow St. In % of Wide St.	Traffic on narrow street in percent of traffic on wide street— 10	25	50	75	100	200	300	400	500	1,000
	Percent of time narrow street is open to traffic—									
40	36	47	58	65	71	78	84	85	86	89
50	34	43	54	61	65	74	79	81	82	86
60	32	41	50	57	61	71	75	78	79	83
70	31	38	47	54	58	67	72	75	76	80
80	30	37	45	51	55	64	69	72	74	78
90	29	35	43	48	52	61	66	69	71	75
100	28	34	41	46	50	59	64	66	68	72

corners. If the street intersection itself is not to be enlarged and additional area included within the street lines, the best curb radius that can generally be used in right-angle crossings is one equal to the least sidewalk width at the intersection. This is the largest radius compatible with retaining a uniform sidewalk width around the corner while retaining existing street lines.

2. *Cutoff Corners*—Cutting off the corners and including additional land within the intersection affords not only greater turning radii to machines but greater visibility of approaching traffic. Both result in additional speed without diminishing the relative safety. As machines need more clearance in rounding curves than in moving along straight lines, cutting off corners even by a moderate amount will greatly facilitate traffic at intersections where many turns are made. They not only increase the safe speed of approach to the intersection but increase the safe speed with which the corners of the intersection may be turned. A cutting off of corners is, as one would naturally expect, of much greater importance to intersecting streets of a narrow width than to streets of a great width. The speeds possible around cutoff corners on streets of different widths, allowing vehicles ample time to stop without colliding, are indicated in Table III.

3. *Building Lines*—Building lines may be established 10, 20, 30 or more feet back of the property lines which will increase the amenities of residence sections by affording planting strips, as well as augment the safety of streets for fast traffic. The setting back of building lines affords a longer view of traffic approaching an intersection. This enables all traffic crossing the intersection to travel faster without any diminution in relative safety. Cutoff corners have a marked effect in enlarging the angle of vision at an intersection but the setting back of building lines has a still more marked effect. Indeed a building line setback, when observed on both streets, need be only half as great as a cutoff to afford the same visibility. In other words a building line setback of 10 ft. on both streets is equivalent to a 20-ft. cutoff. The speed at which two machines approaching an intersection at right angles may safely travel and yet have time to stop without colliding is indicated for streets of different widths and different setbacks in Table IV.

4. *Splaying Out of Streets Near Intersections*—The width of streets may be splayed out at intersections to provide reservoir space for vehicles waiting to cross the intersection. Such an enlargement of streets will enable a greater number of vehicles to cross the intersection in a given time, lessen the time cross traffic is stopped and afford more room for turning vehicles. An inexpensive way of adding to the vehicular traffic capacity of an intersection is by widening the roadway near an intersection at the expense of the sidewalk.

5. *Markers on Pavement*—The different paths to be taken by vehicles through the intersection may be marked upon the pavement so that the different lines of traffic will not interfere with one another.

6. *Prohibition of Parking*—Prohibition of all parking within a distance, say 100 ft., of the intersection is desirable. Parked vehicles at each curb occupy nearly the

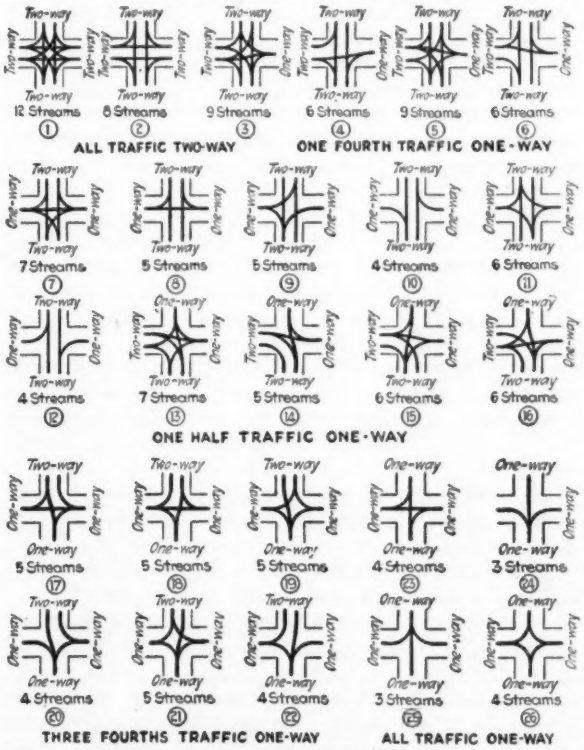


FIG. 4—TWENTY-SIX WAYS OF UNTANGLING TRAFFIC AT STREET INTERSECTIONS

same space as is required by two moving vehicles. The provision of a broad front for waiting traffic enables it to cross in the minimum time when the street is open.

7. *Standards*—Standards should be erected immediately before and after the intersection is reached instead of at the center for left-hand turns. It is quite evident that the necessity of rounding a central standard may result in an appreciable diminution in the traffic capacity of an intersection. This difficulty can, however, be obviated without any lessening of control over traffic by requiring it, in lieu of rounding a central standard, to round standards immediately before entering and after leaving the intersection. The rounding of standards outside of the intersection, moreover, permits the negotiation of turns with greater radii than does the rounding of a central standard, and greater radii are, of course, accompanied with corresponding increases in the speed permissible without any sacrifice in relative safety.

8. *Re-routing of Traffic*—Often much traffic turns or crosses where a more direct way to its destination would

TABLE II—SAFE SPEED IN TURNING AT INTERSECTIONS

Right angled intersections. Sidewalks one-fifth street width. Curb turned with radius equal to sidewalk width. One traffic unit in each direction on 40 and 50-ft. streets; 2 on 60-ft. streets; and 3 on 80-ft. streets.

	Width of Street in Feet			
	40	50	60	80
Miles per hour: (a) Right-Hand Turns				
Free to occupy any part of roadway	13.6	15.8	17.6	20.9
Keep within one-half of street moving near center	8.5	10.3	11.8	14.4
Center of own side and 1 ft. clearance of corner:				
Right unit	6.2	8.5	8.0	8.1
Intermediate unit	....	....	....	9.3
Left unit	....	....	9.3	10.3
Miles per Hour: (b) Left-Hand Turns				
Free to occupy any part of street and not round center	13.6	15.8	17.6	20.9
Keep within own half of street and round center	7.0	8.8	10.3	12.8
Center of own side and 1 ft. clearance of center:				
Right unit	....	....	....	10.1
Intermediate unit	....	....	....	9.1
Left unit	....	....	....	....
Center of own side, clearance at center not required but leaving room for right-hand turns:				
Right unit	9.3	10.7	11.4	13.1
Intermediate unit	....	....	....	12.2
Left unit	....	....	10.4	11.4

avoid the intersection entirely. Existing competing routes should be properly paved so as to attract traffic and where found imperative new thoroughfares should be laid out to divert traffic that can better be taken care of by new routes. Crossing traffic in general should greatly exceed turning traffic, for the crossing streets presumably lead in the directions traffic desires to take.

9. *One-way Streets and Prohibition of Left-Hand Turns*—The establishment of one-way streets and the abandonment of left-hand turns reduces the number of traffic streams flowing through an intersection. This makes the movement of vehicles more orderly. It also reduces congestion. The reduced number of traffic lines where left-hand turns are prohibited or where traffic is routed through the streets one way is shown for different conditions in Fig. 4.

Left-hand turns are particularly obstructive to main traffic as all vehicles making this turn have to cross all traffic coming from the opposite direction and do so while the roadway would otherwise be open for that traffic. No left-hand turns should be eliminated without adequate arrangements first being made for taking care of the additional traffic that will fall upon other intersections.

10. *Synchronized Opening and Closing of Cross Streets*—With one master street controlling the synchronized opening and closing of all cross streets, the main street may be opened from end to end at one time so that traffic may proceed at normal speed for a considerable distance without interruption.

11. *Separation of Fast and Slow Traffic*—Probably nothing retards the free movement of traffic more than intermingling of fast and slow vehicles. The speed of the slowest vehicle tends to become the speed of all the vehicles using a street. The fast vehicle cannot, of course, travel any faster than the slow vehicle in front of it. Promiscuously mixed traffic invariably results in congestion. A separation of fast and slow vehicles is absolutely essential to a mobile condition of traffic at crowded street intersections.

12. *Separation of Grades*—A separation of street grades in eliminating all cross traffic, of course, opens each intersecting street in its entirety to through traffic. Being open all of the time naturally enlarges the traffic capacity of both streets enormously—sometimes several hundred per cent. No stop need be made for cross traffic, and very little reduction need be made in the speed in passing over or under intersecting streets. Indeed, except for the caution required to avoid collision with turning vehicles, all limitations upon the safe speed of approaching intersections are removed.

The Traffic Survey—What should or should not be done to relieve congestion at a particular intersection can be determined only after a careful survey of all the factors affecting its traffic. This survey should include an examination of the physical design of the intersection itself as well as a painstaking analysis of the character and distribution of the traffic in the intersection.

The particular subjects that would have to be studied and the relative importance of each would, of course, differ for different intersections. Among the matters which should be considered are the following:

A. Design of the intersection: (1) Angles of intersecting streets. (2) Width of entering streets. (3) Roadway and sidewalk widths. (4) Curb radii. (5) Physical obstructions in streets, such as trolley tracks, center standards, street lamps, parking strips, shrubbery, etc. (6) Grades. (7) Improvements on property surrounding intersection. (8) Pavements, kind and condition. (9) Roadway crown.

B. Character and distribution of traffic at the intersections: (1) Amount of traffic entering and leaving by several approaches to intersection. (2) Volume of through traffic, cross traffic, right and left-hand turns. (3) Traffic density during maximum period. (4) Origin and destination of traffic. (5) Number and duration of periods street is open and closed to traffic from several directions. (6) Speed of several kinds of traffic. (7) Turning radius of vehicles making right and left-hand turns. (8) Present traffic regulations. (9) Possible improvements in traffic regulations. (10) Comparative maximum traffic volumes under present and improved traffic regulations.

TABLE III—HOW CUTOFFS INCREASE THE SAFE SPEED IN TURNING CORNERS

Right-angled intersections. Sidewalks one-fifth street width. Curb turned with radius equal to sidewalk width. One traffic unit in each direction on 40-ft. streets; 2 on 50-and 60-ft. streets; and 3 on 80-ft. streets. The figures in miles per hour are for the traffic line nearest to the curb.

Amount of Cut-Off Measured Back on Each Street Line	Width of Street in Feet			
	40	50	60	80
Miles per Hour: (a) Right-Hand Turns.				
0	6.2	8.5	8.0	8.1
10	9.0	10.0	9.6	9.7
20	10.4	11.3	10.9	11.0
50	13.9	14.6	14.3	14.4
Miles per Hour: (b) Left-Hand Turns				
0	9.3	10.7	10.4	11.4
10	10.7	11.9	11.7	12.5
20	11.9	13.0	12.8	13.6
50	15.0	15.9	15.7	16.4

TABLE IV—HOW BUILDING LINES INCREASE THE SAFE SPEED OF CROSSING INTERSECTIONS

Setback, Ft.	Width of Intersection Streets in Feet: 40	50		60		80			100		
		Inside Line*	Outside Line†	Inside Line*	Outside Line†	Inside Line*	Intermediate Line‡	Outside Line†	Inside Line*	Intermediate Line‡	Outside Line†
Miles per Hour: (a) Buildings Set Back on One Street Only											
0	14.7	15.2	16.1	17.4	19.1	19.7	21.2	22.7	23.1	24.5	25.7
10	17.0	19.5	19.1	19.4	21.0	21.5	22.9	24.2	24.7	25.9	27.1
20	19.1	19.5	20.9	21.2	22.7	23.1	24.5	25.7	26.2	27.3	28.4
30	20.9	21.3	21.8	22.9	24.2	24.7	25.9	27.1	27.6	28.7	29.7
40	22.7	23.0	24.2	24.5	25.7	26.2	27.3	28.4	28.9	30.0	31.0
Miles per Hour: (b) Buildings Set Back on Both Streets											
0	14.7	15.2	16.1	17.4	19.1	19.7	21.2	22.7	23.1	24.5	25.7
10	19.1	19.5	20.9	21.2	22.7	23.1	24.5	25.7	26.2	27.3	28.4
20	22.7	23.0	24.2	24.5	25.7	26.2	27.3	28.4	28.9	30.0	31.0
30	25.7	26.0	27.1	27.3	28.5	28.9	30.0	31.0	31.3	32.3	33.3
40	28.5	28.7	29.7	29.9	31.0	31.3	32.3	33.3	33.6	34.5	35.4

* Inside Line: Vehicle approaching intersection on curb traffic line and cutting nearest line of cross traffic from the right or approaching on center traffic line and cutting nearest line of cross traffic from the left.

† Outside Line: Vehicle approaching intersection on center traffic line and cutting nearest line of cross traffic from the right or approaching on curb traffic line and cutting nearest line of cross traffic.

‡ Intermediate Line: Vehicle approaching intersection on intermediate traffic line and cutting nearest line of cross traffic from the right or nearest line of cross traffic from the left.

Recent British Concrete Road Practice

Two Courses of Different Mixtures Placed at Once —Surfaces Coated with Tar, Sprinkled with Stone Chips

By Major Johnstone-Taylor
Shrewsbury, England

MUCH attention is being paid in Great Britain to the use of reinforced concrete in connection with an extensive program of road construction. New roads are an urgent necessity, especially on the outskirts of the big cities, because new work was entirely suspended during the war period. At the same time the unemployment problem has been the means of local authorities getting substantial government assistance to cover part of the cost of big works, the most extensive of which is the new Liverpool-Manchester road which will be some 27 miles in length and cost several million pounds sterling, besides employing some 20,000 men for a considerable period.

London Road—The first section of this new route to the west is being built of reinforced concrete, is 7½ miles long and is 100 ft. wide between fences. There are two 16-ft. carriage ways. The reinforced slab has a total thickness of 8 in. of which the lower 5 in. is a 1:2½:5 and the remainder a 1:1:3, mixture.

The reinforcement is of a special kind, known as the Walker-Weston, consisting of a double-layer framework 5 in. deep made up of ⅜-in. top and bottom bars with No. 6 s.w.g. annealed mild steel bars which connect the two layers, the total amount of steel used per super yard being 10 lb. and its price laid about 89c.

The concrete, which is machine mixed, is deposited to the full depth, leveled and consolidated by a petrol-driven mechanism tamper which is fitted with a cambered screeding beam followed by a cambered tamping beam giving a three-ton blow. After being laid the concrete is covered three weeks with damp soil kept moist

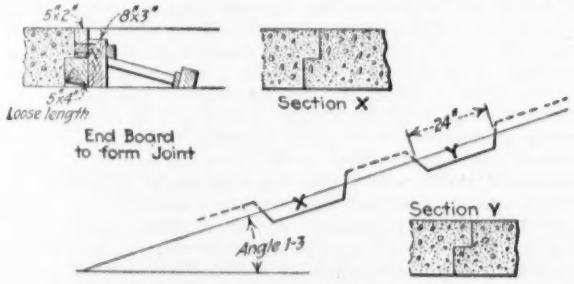


FIG. 1—PAVEMENT JOINT CONSTRUCTION

and then finally is tarred and gritted. It is interesting to note that no expansion joints are provided.

New System of Construction—The Walker-Weston Co., which, it was stated were responsible for the reinforcement of the London road, have introduced a new system of construction which adopts the principle of laying the concrete in alternate bays, allowing one set to contract before working on the other, while special forms are used to ensure that the edges of the bays are truly vertical. Thus in place of say 1 in. contraction in every day's work of 100 ft. there are straight joints ⅛ in. wide, which, while acting as expansion joints will be covered by the tarred surface. Moreover, in place of laying the bays square with the curb they are laid at an angle so that at no time will a joint have more than one wheel of a heavy axle upon it. In addition to the edges being accurately vertical they are also locked so that the load at all times will be borne by two slabs in place of one. Details of the plan are given in Fig. 1.

This system provides for the whole depth of the concrete being laid at once so as to insure that the laitance scum will only form on top and from where it is carefully removed before tarring is attempted. Of course the laying of, say 49 ft. width of road in alternate bays provides no easy construction problem, but it has been satisfactorily solved by the use of a special form of cableway crane which spans the track and also provides for covering it in wet weather so that work can go on continuously. The crane runs on temporary tracks.

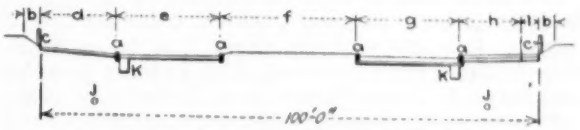


FIG. 2—CROSS-SECTION OF MANCHESTER ROADS
a, Concrete curbs 12 x 8 in. on 2½-in. concrete; b, slopes 45 deg.; c, reinforced concrete fence posts; d, 16-ft. section covered with 3-in. cinders; e, 20-ft. section covered with 6 in. cinders; f, space for street car tracks 28 ft. wide; g, finished road 20 ft. wide; h, footway 2½ in. artificial flags on ½ in. of sand on 3 in. of cinders; j, drains 11½ in. wide; k, catchpits; and l, 3 in. of gravel on 3 in. of cinders, 4 ft. 4 in. wide.

Manchester Roads—Strictly speaking these are not reinforced concrete roads, reinforcement only being used in the case of bad foundations and on embankments of which there are several owing to the network of railroads to be traversed. Reinforcement is also used over cross trenches of gas, water and electric mains.

The general section of these roads is shown in Fig. 2. Provided the foundation is capable of supporting 1½ to 2 tons per square foot, the carriage way is constructed as follows: Three inches of ashes or clinker are rolled and consolidated on the natural foundation, and after well watering the concrete is laid on this bed, one layer of 5 in. of 1:2½:5 and the other 2 in. of 1:1:2. The stone for the bottom course is good hard stone gotten locally and varying from 1½ in. to ¼ in. gage, but that for the top course is granite ¾ in. to ¼ in. gage and granite grit is used in place of sand. The alternate bay system was adopted, each bay being 14 ft. long and those placed first being allowed 14 days to set before the others were commenced. Each bay was completed without cessation of work and the top and bottom courses completed practically simultaneously, the upper surface being finished off with a wooden templet to a cross fall of 1 on 60, no trowelling being permitted.

The embankments, which owing to the urgency of the work, have not had time to consolidate thoroughly, are watered and rolled and the reinforced concrete laid on a well rolled foundation of ashes the depth of the concrete being 9 in.; otherwise the construction is similar to the rest of the work. As regards reinforcement, 1 in. of concrete is first laid and on this is placed the reinforcement which is 6 in. in depth and then concrete worked into the reinforcement to cover it to a depth of 2 in.

The concrete is of the same proportions and sizes as used on the other portion of the work but granite and granite dust are exclusively used. One length of the road passes over a mile of peat bog which, after 18 in. of excavation below formation level, is filled in with ashes and clinker rolled and filled up again as sinkage

takes place. In most cases a weight of 2 tons per square foot could be supported after repeated fillings and rolling but in some cases wattle hurdles are necessary to assist the consolidation. Over this bog the concrete is 12 in. thick and the reinforcement is 9 in. deep, while the carriage way extends 30 in. beyond the curb for support to vehicles running near the roadside.

Protective Coatings—On the Manchester roads ordinary tar spraying has been tried and it has not been a success. It is now generally conceded, as far as conditions in Britain are concerned, that, in order to make concrete roads a complete success it is absolutely essential that some thin, strongly-adhesive coating cover the concrete surface and that it should be easy, cheap and quick to renew.

Covering is considered necessary in order to remove glare in the strong sun, act as a waterproof coat, give foothold for horses, and act as a buffer to iron tired vehicles.

Neither tar nor asphalt will adhere to a concrete surface unless the laitance scum is removed as the concrete is completed. This scum merely turns to fine dust and acts as would French chalk. Some experiments have been made and as a result it is recommended that the top surface shall be finished with larger aggregate than used, and the laitance scum washed off the day after setting. A rough pock-marked surface will result. The traffic is allowed to go over this for a week or so after which it is tar sprayed and sprinkled with granite chips. This has been found to provide a waterproof non-slipping surface in every way comparable with the best tar macadam, which it may be remarked is an unqualified success in Britain.

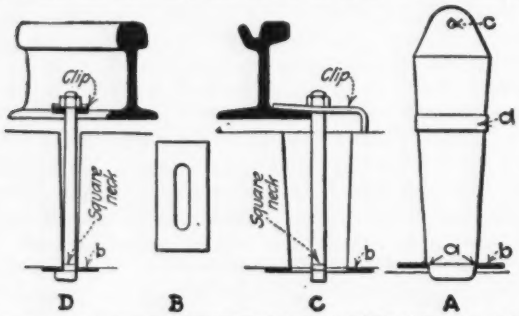


FIG. 3—ATTACHING STREET RAILWAY TRACKS TO SLAB

Fixing Street Car Tracks—These concrete roads which are being made in Britain are, as stated, located for the most part on the outskirts of the big cities and the question of fixing street car rails had to be given consideration. It was no easy matter to find a satisfactory solution of the problem but the arrangement shown in Fig. 3 has been found a good method. After the formation has been leveled off and the usual interlocked double layer of reinforcement placed in position the approximate position of the rails is marked out and on these lines wooden templets are fixed (Fig. 3 *A*) having a rabbeted end at *a* and a thin metal base *b*. When sufficient of these are set up the concrete is leveled up to the underside of band *d*, the top edge of this band being at the exact level of the underside of the rails to be put down.

The templets are then eased when the concrete has part set and removed when it is hard. This leaves holes in the shape of Fig. 3 *B* with the thin metal base *b* left behind. The rails are now packed up on the hard concrete and square neck bolts dropped into the holes as shown in views *C* and *D*. These bolts are then pushed down below the metal plate, given a half turn so that the neck fits in the slot of the plate allowing the nut to be tightened up without the bolt turning. The rail is then fixed by the slip shown.

As the nuts are screwed down the rails are tightened up against the packing pieces, the bolt holes are filled up with sand and concreting is resumed. No great accuracy is required in fixing the templets but the rod connecting them and passing through *c* (view *A*) must be carefully adjusted to rail level so that the grouting space under the rail will be uniform and a uniform length of bolt can be used. It will be noted that as lewis bolts are not used the rails can be renewed without renewing the bolts as the bolt holes are filled with sand only. It is usual of course to complete the road surface between the tracks and for 12 in. each side with granite setts run with tar so that when the tracks are renewed the concrete is undisturbed.

For and Against the Am. Soc. C. E. Joining the Federation

Abstract of the Opposing Views Prepared Each by Three Members of the Board of Direction to Accompany Referendum

Under date of Feb. 15, *the American Society of Civil Engineers issued to its members ballots to be canvassed April* 6, *as to whether the society shall affiliate with the Federated American Engineering Societies. Accompanying the ballots are the arguments in favor of and opposed to the proposal, these having been prepared by two committees of the Board of Directors appointed for the purpose. For the information of those to whom copies of these arguments may not be available the following abstract of the major points is offered.*

Arguments in Favor—Herbert Hoover endorses the F.A.E.S. and expresses the opinion that the Am.Soc.C.E. should join. The history of the federation movement shows that the several conferences and bodies that considered the subject all expressed a desire for a single comprehensive organization to effect engineering unity. The purpose of the F.A.E.S. is fundamentally sound and is approved by many who oppose it on other grounds. It is not a super-society and was organized to overcome the defects of Engineering Council, which was not sufficiently democratic or representative and was inadequately financed.

F.A.E.S. is representative and democratic. Engineering Council had only six member-societies and represented an aggregate membership of about 40,000, whereas the F.A.E.S. has twenty-eight member societies representing a total of nearly 50,000. If the Am.Soc.C.E. should join, this would be increased to 60,000. Two member-societies have been added and a third has voted to join. Three have withdrawn temporarily because of financial conditions. F.A.E.S. has increased in the membership of member-societies from 41,932 in 1921 to 49,587 on Feb. 1, 1923. The organization is representative, the Societies having in the council one member for each 1,000 members or major fraction thereof, with a minimum of one for each member-society. Of the 64 members of the council, many who represent local societies are members of one or more founder societies, so that the latter are represented by 79 memberships on the council. The executive board of the council consists of 6 officers and 24 members of whom 30 per cent are members of the Am.Soc.C.E. In the council 32 per cent are members of the Am.Soc.C.E.

Greater solidarity for the profession is obtained through F.A.E.S. than was possible through Engineering Council because the headquarters of the member-societies are dis-

tributed throughout the country in 24 cities. Membership in F.A.E.S. is voluntary and may be terminated at three months' notice. The Am.Soc.C.E. cannot be committed to membership for more than a year at a time. The organization is economically administered and its budget is not extravagant as compared with that of the former Engineering Council. F.A.E.S. does not undertake technical work within the purview of a founder society and does not undertake to give engineering advice without charge, as has been alleged.

A canvass of the local sections of the Am.Soc.C.E. during 1922 showed 16 sections in favor of joining the F.A.E.S. and 10 opposed, with 4 sections in favor when the finances of the society should permit. The 1923 budget of the Am.Soc.C.E. provides for an increased allotment to local sections from $1 to $2 per member, new allowance for technical divisions of $4,000, allotment to technical committees of $10,000 as against an expenditure of $4,023.51 during 1922, and dues for nine months membership in the F.A.E.S. amounting to $7,800; after which remains an unappropriated surplus of $653. The votes of the Board of Direction on Oct. 3, 1922, and on Jan. 16, 1923, sympathetic to joining the F.A.E.S. showed that all the affirmative votes were cast by directors representing other than District 1, and that in each case only one negative vote was cast by a director residing west of District 1. More than 70 per cent of the members in attendance at the annual meeting in January 1923 were residents of District 1.

A ballot canvassed in April 1920 showed a vote of three to one in favor of the Am.Soc.C.E. "becoming an active national force in economic, industrial and civic affairs" and "actively co-operating with other engineering and allied technical associations in promoting the welfare of the engineering profession." The society co-operated in creating Engineering Council to carry on similar activities and F.A.E.S. succeeded to these. If the Am.Soc.C.E. were in the F.A.E.S. a greater percentage of the council would be of its membership than was the case with Engineering Council.

Every engineer is obligated to the advancement of his profession, particularly in its service to the public. The Am.Soc.C.E. cannot hold aloof from joint activities of other engineering societies and be effective any more than a state could co-operate with the government of the United States without being in the Union. No more would it lose any of its individuality or prestige by reason of membership. In the settlement along right lines of certain national economic problems, as for example, transportation, reforestation, and the reduction in the cost of living, the viewpoint of engineers can be more helpful to the government than that of any other group of citizens. There is general agreement among engineers that a council of American Engineers is desirable. F.A.E.S. is designed to be responsive to its member-societies. The member-societies would gladly co-operate to make it even more so. The purpose being sound, the machinery may be changed from time to time to meet the needs of the member-societies. F.A.E.S. now has a committee engaged in revising its constitution and by-laws; if the Am.Soc.C.E. were in, it could mold these to the plan it thinks desirable. If the name "Engineering Council" is thought to be more desirable the change doubtless can be accomplished.

Arguments Against—There has been no change in conditions to justify a reversal of the 1920 verdict of the Am.Soc.C.E. by which it voted 3,278 to 2,330 and 13 districts to 9 against the proposal. The Am.Soc.C.E. is the only founder society that submitted the question to referendum. Participation by the society in the F.A.E.S. would be in violation of its cardinal principle that engineering prestige must rest on professional attainment and standing, for which no qualifications are prescribed for membership in the F.A.E.S.

The Am.Soc.C.E. is willing to co-operate to advance the profession and the public welfare but is unwilling to surrender its name or reputation for exploitation by any organization not within its control or responsive to its judgment. To join the F.A.E.S. would mean the delegation to an outside body, in which it would have an insignificant voice, of the right to speak on behalf of its members without respect for their views on any particular issue. Representation in the federation is inequitable, in that each society of more than 100 members is entitled to a vote whereas the national society of large membership and high standards is limited to one vote for each 1,000 members. The fact that representatives of local societies may be members of the national society does not alter this condition for no man, true to his trust, can represent more than one organization.

It has been demonstrated that the F.A.E.S. is not responsive, that the national societies have no control over its actions and that its management is tending toward the establishment of a super-society designed to control the public relations and policies of its constituent societies. The secretary has stated that no changes in organization are contemplated. If the Am.Soc.C.E. should join the F.A.E.S. by referendum it would require another to withdraw, whereas the other national societies are in by vote of their governing bodies only and can withdraw in like manner.

The record of the F.A.E.S. does not inspire confidence in its organization or management. While it has co-operated in a number of enterprises it is believed that the net results of its efforts have been exaggerated, that they could have been attained by joint committees of existing societies and that they have not been commensurate with their cost. Its legislative activities at Washington have been of questionable value. Although professing to speak for the engineers of the country it is not subject to referendum as are responsive federations, and there is danger of its becoming an instrument of propaganda susceptible to exploitation at the hands of a few. The publicity of the F.A.E.S. is of questionable value to the profession and there is danger that this too may lead to unworthy exploitation of the organization. The employment service inherited by the F.A.E.S. from Engineering Council was soon turned back to the founder societies.

Dissatisfaction has developed within the F.A.E.S. on the ground that the member societies have too little voice in the management and that there is a tendency toward the formation of a super-society. Although 66 societies were represented at the organization conference less than one-half joined. Last October two-thirds of the 27 member societies were in arrears for dues. Since then the Baltimore Engineers' club has withdrawn and others are reported to be on the point of doing so. The American Institute of Mining and Metallurgical Engineers has given notice of withdrawal and is being kept in the F.A.E.S. by private subscription. The Boston Society of Civil Engineers also has been kept in by private subscription.

After the Am.Soc.C.E. has paid its fixed expenses of administration it has $40,000 available for meetings throughout the country, committee work, promotion of technical activities and local sections. The F.A.E.S. dues must be found at the expense of these activities. At the normal rate of $1.50 per member these would be 40 per cent of the available revenue; at the present reduced rate they are 25 per cent. The $7,800 provided in the budget for this purpose was obtained by paring the appropriations until the technical committees are to receive only 60 per cent of their estimated needs. An effort to increase the yearly allowance to the local section by $10,000 was defeated for the same purpose. It is considered that the interests of the society would be better served by appropriating money to the local sections than by paying it to the F.A.E.S. It is believed that if the society should join the F.A.E.S. there will hereafter be a deficit of $11,000 (or, if the normal dues should be restored, $16,000), to the further detriment of the society's primary interests. The present proposal comes not from a general demand but because of the insistence of a small group associated with the F.A.E.S. as representatives of affiliated organizations. The Am.Soc.C.E. will best serve its members, its profession and the general welfare by declining to join the F.A.E.S. and by exerting its influence in co-operation with other societies of comparable standing and similar purpose without prejudice to its own independence or continued usefulness to its members.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Design for Small Irrigation Flume

Sir—Herewith is a design for a small irrigation flume similar to the one shown in my article in your issue of Dec. 7, 1922, p. 967. We are preparing to build one of these flumes over a drain ditch some time this month (another corrugated pipe failed). The work will be done by force account instead of by contract as we figure that we can thus save a considerable amount.

This flume is designed to carry 6 sec.-ft. of water at a velocity of 2 ft. per second, with a total loss in head of 0.12 ft. Six second-feet will equal what we term three "heads" of water, and will be sufficient for small distribution laterals. By a head of water is meant the amount one good irrigator can handle efficiently.

The ¾-in. bars in the barrel of the flume are placed in the exact center of the concrete (seemingly at the neutral axis). We have found that a wall of less than 4-in. thickness is not economical; that is, we can build a 4-in. wall as cheap as a 3-in. wall, due to the fact that a very thin wall is extremely hard to pour without a number of rock pockets, and contractors will bid higher per yard on the thin-wall structures so that the saving in material is offset by the extra labor charge. By placing the ¾-in. bars in the center, we get a *d* of 2 in. and one set of bars will take care of both positive and negative moments.

Only one pile is used on each support. On the center bents we will drive 20-ft. piles, break off 20 in. to make the lap on the bars, and after forming pour to the required height. This will be done because the 30-ft. pile could not be handled without danger of breaking. The 1½-in. pipe reduced to 1 in. at the bottom is placed in the center of each pile, and the piles will be jetted instead of driven.

W. F. HEATH,
Assistant Engineer, Cameron County Water Improvement District No. 2.
San Benito, Texas, Jan. 19, 1923.

Effect of Integral Waterproofing Compounds on the Strength of Concrete

Sir—At the recent meeting of the American Concrete Institute considerable interest was shown in a discussion of the function of integral waterproofing compounds in concrete. We have recently made a series of tests to determine the effect of these compounds on the *strength* of concrete. The tests formed a part of a series of laboratory and field researches on concrete exposed to sulphate soils and waters.

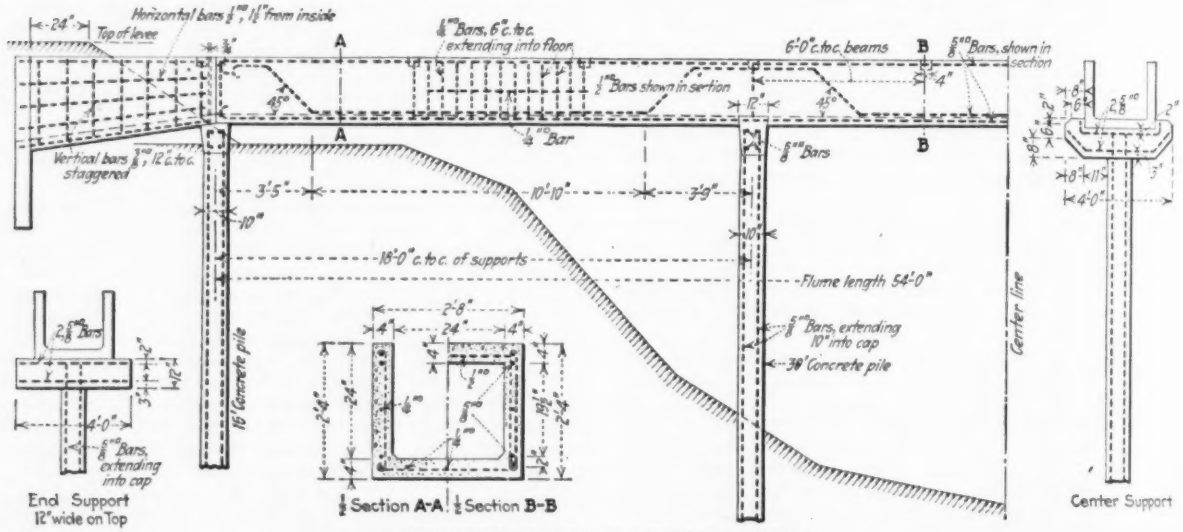
Compression tests were made on 6 x 12-in. concrete cylinders, in which 11 different integral waterproofing compounds were used in 1:3, 1:4 and 1:5 concrete mixtures, with aggregate graded up to 1½ in. In a number of instances, two or three percentages of the compounds were used.

The tests were made at the age of 28 days after curing the concrete in a moist room.

Without exception, the compressive strength of the concrete was reduced by these compounds. "Normal" concrete, that is without integral compounds, gave the following strengths: 1:5, 3,010; 1:4, 3,460; and 1:3, 4,230 lb. per sq.in.

A soap solution of ¼ lb. per gal. of mixing water gave a concrete strength 57 per cent of normal; 5 per cent crude oil (both asphaltic and paraffin base), gave concrete strengths 73 per cent of normal.

Four different proprietary waterproofing compounds, used in the percentages recommended by the manufacturers, gave concrete strengths 74 to 87 per cent of normal; average about 80 per cent. A so-called alkali-proofing compound (patented) gave concrete strength 16 per cent of normal.



IRRIGATION FLUME FOR SMALL LATERAL

Little difference was found in the relative effect of integral compounds due to the quantity of cement within the range of the mixes used in these tests.

We have made no tests on the value of these compounds for waterproofing, and at this time no conclusions can be given with reference to their effect in concrete exposed to sulphates. However, users of such compounds should consider that the strength and probably the resistance of the concrete to destructive agencies may be seriously reduced thereby.

DUFF A. ABRAMS,
Professor in Charge, Structural Materials, Research Laboratory, Lewis Institute.
Chicago, Ill.,
Feb. 14, 1923.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Special Assessments Subject at Water-Works Meeting

C. M. Saville Summarizes Data Gathered by Him—Next Meeting to Be at Rochester, April 7

Following lunch and the transaction of business on Feb. 21, the New York Section of the American Water Works Association discussed the assessment method of paying for extensions to water mains. A vacancy on the Board of Governors of the section was filled by the election of Thaddeus Merriman, chief engineer Board of Water Supply of the City of New York. It was announced that the section will hold a meeting at Rochester, N. Y., on April 7, a feature of which will be a visit to the local water-works repair shop and yards.

The discussion on assessments was opened by Caleb M. Saville, chief engineer and manager of the water-works of Hartford, Conn., who summarized data thus far gathered by him for a paper to be presented to the annual convention of the association at Detroit, next May. Mr. Saville stated that more cities were levying assessments for water mains than he had supposed and that a variety of methods are in use, some of which are essentially guarantees of a stated percentage yearly revenue on the cost of the extension. Hartford operates under the guarantee plan. The Connecticut legislature, two years ago, placed municipal water-works accounting under the control of the State Utility Commission. Mr. Saville believes that the cost of main extensions should be charged to capital.

Discussion

In the discussion, W. W. Brush, New York City, stated that with consolidation frontage charges in New York had been abolished. A change from established practice is likely to create a general feeling of injustice. Lack of protest against existing practice indicates public approval. Nicholas S. Hill, Jr., said that with the bringing of private water companies under the control of state utility commissions the former are no longer operated for profit, but merely to pay current charges and a fair return on the investment. Municipally-owned works should be run on the same plan. Allen Hazen remarked that so far as he knew there are only five large cities in this country that assess the cost of water main extensions on the abutting property: Philadelphia, Milwaukee, St. Paul, Seattle and Los Angeles. These cities have low water rates because so much of the cost of their water-works systems has been raised as stated. The assessment plan is logical, but if adopted should be continued in use.

M. N. Baker, New York City, stated that as a rule, assessments for water mains have not been made in accordance with the underlying principle of assessments for benefits, which puts the cost of the improvement on the property benefited, but have been on arbitrary front-foot charge, made necessary because of water main extensions into sparsely settled territory. Control of city growth through planning and zoning would lessen the number of such extensions. Robert B. Morse, chief engineer, Washington Suburban Sanitary District, outlined the plan of financing both water-works and sewers in use in the district named, which rests on the theory that the entire capital cost of these improvements should be met from (1) taxes and (2) property assessments, the latter chiefly for small water mains and sewers, in the form of a yearly charge covering interest and bond retirement charges, and terminating when the bonds are paid off (see *Engineering News-Record*, June 2, 1921, p. 944).

Southern Pacific R.R. Will Build 118-Mile Cutoff

It is announced by the Southern Pacific R.R. that following the approval by the court of the Interstate Commerce Commission's recent decision permitting the Southern Pacific to retain control of the Central Pacific, construction of the section of the Natron cutoff between Oakridge and Kirk, Ore., will be undertaken. The gap at present is 118 miles long over the Cascade Mountains and its closing will provide a new north and south line from Weed, Calif., to Eugene, Ore.

Experts Appointed to Make Plan for New York and Environs

The names of six city planners to make a study for a regional plan of New York City and vicinity covering some 5,000 square miles have been announced by the Committee on the Plan of New York and Environs, acting under the auspices of the Russell Sage Foundation. The six are Thomas Adams, of Adams & Thompson, London and New York, chairman; Harland Bartholomew, city planning consultant, St. Louis, Mo.; Edward Bennett, of Bennett, Parson, Frost & Thomas, Chicago (Mr. Bennett having been a partner of the late Daniel H. Burnham); George B. Ford, of the Technical Advisory Corp., New York City; John Nolen, landscape architect and city planner, Cambridge, Mass., and Frederick Law Olmstead, landscape architect, Brookline, Mass. Mr. Adams was formerly associated with the British Local Government Board; then was town planning adviser to the Canadian Conservation, and has recently opened offices in New York and London. He is lecturer on civic design at the Massachusetts Institute of Technology. A preliminary report is to be submitted by Oct. 1.

U. S. Chamber of Commerce Tackles Transportation

Will Appoint Committee Representing All Interests to Seek Effective Co-Ordination of Facilities

Following an informal meeting held recently in New York City at the call of Julius H. Barnes, president of the Chamber of Commerce of the United States, for the consideration of transportation problems, Mr. Barnes has taken steps to form the general committee recommended by the meeting. That meeting was attended by Herbert Hoover, who was present informally; Julius H. Barnes, president, Chamber of Commerce of U. S. A.; Carl R. Gray, of Omaha, chairman of transportation department committee; George A. Post, of New York, chairman of waterways committee of the Chamber of Commerce of U. S. A.; Samuel Rea, president, Pennsylvania System; A. H. Smith, president, New York Central Lines; Hale Holden, chairman, railway executives; Howard Elliott, representing Northern Pacific and N.Y., N.H. & H. R.R.; C. H. Markham, president, Illinois Central; Daniel Willard, president, Baltimore & Ohio; W. D. Storey, president, Atchison, Topeka & Santa Fe; A. J. Brosseau, president, Mack Truck Co. and director of Chamber of Commerce of U. S. A.; J. Walter Drake, president, Hupmobile Corp., and director of Chamber of Commerce of U. S. A.; Alvan Macauley, president, Packard Motor Car Co., of Detroit; A. H. Swayne, General Motors Corp. of New York; George M. Graham, Chandler Motor Car Co., of Cleveland, and C. P. Craig, Duluth.

All Interests Represented

The resolutions adopted at this meeting requested President Barnes to form a general committee composed of representatives of the railways, shipping interests, producers, motor industry, waterway operators and the public, which should consider the transportation problem with regard to governmental relations, possible railroad consolidations, and readjustments of rate schedules, proper co-ordination of railroads, motor transport and waterway service. The committee is to provide for contact with the Department of Commerce, the Interstate Commerce Commission and any other agencies of government. It will convene at the call of the president of the Chamber of Commerce and probably will work through sub-committees for study and investigation leading to its reports and recommendations.

The Chamber of Commerce has announced progress in the organization of the general and sub-committees to study the various phases of the problem, and hopes to be helpful in working out a national transportation program that will care for trade expansion already in sight.

Further developments will be presented to the board of directors and the membership at an early date.

Wisconsin Engineers Hold Annual Meeting

Many Progressive Ideas Discussed—Joint Session Held With Drainage Association

Engineering News-Record Staff Report

A permanent society headquarters at Madison, a code of ethics, a state registration law for engineers, and a movement for closer co-operation of all technical associations in Wisconsin, were definite recommendations made at the annual meeting of the Engineering Society of Wisconsin, held at Madison, Wis., Feb. 22 to 24. Some of the sessions were held jointly with the Wisconsin Drainage Association and the annual dinner was held jointly with the Technical Club of Madison. An unusual publicity feature was a large advertisement of the dinner and the speakers, published in the local papers by the Technical Club.

Permanent Offices

The suggestion for permanent offices was made in the presidential address of Jerry Donahue (Sheboygan). The adoption of the code of ethics already recommended by a joint committee of the four national engineering societies was advocated by Daniel W. Mead (Madison), as preferable to the preparation of any new code. A proposed registration law was submitted by a joint committee representing five local technical associations and headed by K. H. Talbot (Milwaukee). As an argument for this law it was pointed out that Wisconsin is surrounded by States requiring registration, so that Wisconsin engineers cannot practice outside without passing an examination, while outside engineers are free to practice in that State. Although the bill provides for a "board of examiners of architects, engineers and surveyors" it does not specify what classes of engineers are to be included, so that apparently it would apply to mechanical, electrical and other engineers, while its special purpose appears to be the protection of civil engineers.

A review of Wisconsin's highway work by A. H. Hirst, state highway engineer, drifted into a general attack on the railroads, Mr. Hirst claiming that they have made no improvements in transportation for twenty years. Nobody undertook to puncture this soap-bubble, the purpose in blowing which was not clear. Tile drains placed directly below the edges of the paved roadway and having laterals to the side ditches were advocated by E. H. Rossiter (Chicago) as more effective than ditch drains, but Mr. Hirst considered that no tiling could provide for spring rains and floods.

Land Drainage and Sanitation

Relations of land drainage to sanitation, as in the elimination of mosquitoes, yellow-fever and typhoid, were reviewed by L. K. Sherman (Chicago). He considered that the use of public water for sanitation should be considered before the rights of navigation and water power. Sanitation is a matter for engineers rather than medical officers of local boards of health. He advocated the New Jersey system by which land outside of drainage districts pays an assessment on account of sanitary benefits. Further, the county or State should pay a share of the construction cost of such districts for the same reason. In the discussion, C. M. Baker (state sanitary engineer) pointed out that drains should not be used as sewers, as has been done in some cases, with consequent pollution of streams.

That engineers are largely responsible for the generally neglected condition of sewage treatment plants was the opinion expressed by W. H. Copeland, chemist of the Milwaukee Sewerage Commission, in discussing a paper on "Effective Sewage Treatment" by Paul Hansen (Chicago). The plants are frequently too small and have too little provision for sludge disposal, so that they become a nuisance, but as the engineer locates these plants in outlying places the nuisance does not arouse public opinion to demand efficient operation. Mr. Copeland might have noted that in many cases public opinion would not permit such plants to be located in any but an outlying place. However, he considers the solution of the difficulty lies in educating public opinion as to sewage disposal by means of public addresses and articles in the local papers. As to sludge disposal, he considers that too much liquid is used in sludge digesting chambers and too little moisture in the drying beds.

With an attendance of about 300 at the annual dinner the attractions were an address by C. F. Loweth, chief engineer of the Chicago, Milwaukee & St. Paul Ry. and president of the American Society of Civil Engineers, and moving pictures illustrating the manufacture of cast-iron pipe.

Engineers Invited to Inspect New Niagara Power Tunnel

The Niagara Falls Power Co. has extended an invitation to all engineers and contractors to inspect the large power tunnel now nearing completion on the American side of the falls. Water is to be turned in about April 1, and the period of inspection has been set from March 20 to April 1.

This tunnel, described in *Engineering News-Record*, April 27, 1922, is the largest water-power tunnel yet built. It is 4,500 ft. long and has a horseshoe-shape section 32 ft. high and 32 ft. wide inside a 2-ft. concrete lining. At its entrance there is a wide and deep inlet excavated in the bed of the Niagara River terminating in a bell mouth portal to the tunnel. From that point the tunnel dips down to a depth of 120 ft., passing underneath the City of Niagara Falls, N. Y., and emerging at the canal basin near the brink of the Niagara Gorge about half a mile below the falls. At the outlet end of the tunnel is a forebay from which three penstocks will carry the water to the power house situated at the water's edge below the high bank.

Third Member Added to California Highway Commission

After some delay, Friend W. Richardson, Governor of California, has named Nelson T. Edwards, member of the board of supervisors of Orange County, as the third member of the California State Highway Commission. The other two members are Harvey M. Toy, San Francisco, chairman, and Louis H. Everding, Eureka.

New York Section, Am. Soc. C.E., Would Save High Bridge

Resolutions passed at the meeting last Friday of the New York Section, American Society of Civil Engineers, called for the appointment of a committee, members of which are socially versed in deep foundation and masonry arch design and construction, to investigate conditions at High Bridge, with a view to preserving the structure which, according to news accounts, is again in danger of being demolished as an obstruction to Harlem River traffic. Because its utility, historic importance and beauty are such as to commend its preservation this committee together with any other society committees which may be appointed is to study the situation, and to report (1) on the engineering and aesthetic feasibility of modifying High Bridge to make it meet legitimate needs of Harlem River navigation, and (2) on the approximate cost of such rehabilitation as against the cost of demolition and replacement by a new structure for carrying the aqueduct of the Croton water supply for New York.

The meeting also by resolution endorsed the proposed constitutional amendment in New York which would combine the offices of the state engineer with that of superintendent of public works, but went on record as emphatically opposing that provision of the amendment which simply provides that the combined offices be administered by a practical civil engineer. The section embodied in a resolution protests that the combined offices should be under a professional engineer with not less than 15 years experience and training in engineering work.

Discussion of the proposed benevolent fund for the society brought out the fact that many of the members were still undecided as to its merit. Motion was passed therefore that the chair appoint a committee of five members, including one or more members of the board of direction of the section, to prepare a concise statement to be presented to the section at the April meeting, at which time a vote may be taken.

The section held an informal debate upon the merits of the proposal now before the society that it affiliate with the Federated American Engineering Societies, in the course of which J. Parke Channing, a vice-president of the Federation presented a statement of why, in his opinion, the Am. Soc. C. E. should affiliate. Nelson P. Lewis, Lewis D. Rights and Col. J. P. Hogan presented arguments against the society's becoming a member-society of the Federation.

Memorial to B. F. Cresson, Jr., Held in Trenton

A memorial to the late B. F. Cresson, Jr., chief engineer of the New York Port Authority, was held at Trenton, N. J., Feb. 19. J. Spencer Smith presided and read a letter of appreciation of Mr. Cresson's work from Governor Smith. Speakers, all of whom eulogized the professional and private life of Mr. Cresson, included: Senator Clarence E. Case and Assemblyman Herbert Pasco, of the N. Y. Legislature; J. Hampton Moore, Mayor of Philadelphia; Lewis H. Pounds, W. L. Saunders, Richard C. Jenkinson and Thomas A. H. Hay.

Am.Soc.C.E. Board Directs Draft of Model License Law

It is announced by the American Society of Civil Engineers that the following resolutions with regard to the licensing of engineers were adopted at a meeting of the board of direction held on Jan. 19, 1923:

Whereas: Twenty-two states have recently passed laws for the registration or licensing of professional engineers and there are laws pending in the legislatures of more than five additional states, and while there are many engineers strongly in favor of such laws, there are many engineers opposed to such laws, therefore be it:

Resolved: That the society should recognize a tendency in the adoption of laws for the registration or licensing of professional engineers and while at this time it is not advisable to undertake to secure the passage of laws in states in which such action is not already contemplated, it should be its endeavor when such legislation is proposed, to advocate the adoption of uniform laws, properly drafted, for the protection of the public and the engineering profession; and it should also be its endeavor to secure such modification of objectionable features in existing laws so as to bring them into conformity with a uniform law approved by this society.

Resolved: That in order to meet the existing circumstances in states where such laws are proposed, this board advises the postponement of such proposed legislation pending a fuller agreement within the engineering profession in the matter of registration or licensing of professional engineers. And be it further:

Resolved: That the committee on registration of engineers be instructed to present for the consideration of the board at its meeting in New Orleans, April 16-17, 1923, a method of procedure by which this society may actively carry out the policy enunciated in this resolution and submit a draft of the law, which in its opinion, is desirable for general adoption.

Propose New Hudson River Tunnels as Business Venture

The incorporation of the Interstate Vehicular Tunnels Co. for the construction and operation of twin vehicle and pedestrian tunnels under the Hudson River, extending from some point on the New York shore between 23rd and 42nd Sts. to New Jersey, is contemplated in a bill that has been introduced into the New York and New Jersey Legislatures. The incorporators named in the bill are Frank M. Williams, formerly state engineer of New York; Darwin R. James, New York, and Newton H. Porter, of New Jersey.

Under the terms of the bill the tunnels would revert after fifty years to the cities that it is to connect, but the states or cities may recapture them five years after their completion. The cost is estimated at $30,000,000, which is very close to that of the Interstate vehicle tunnel now under construction.

The tolls fixed in the bill for passage through the tunnel vary from 5c. for pedestrians to 80c. for automobile trucks and buses having a wheel base between 15 and 17 ft. in length.

Bill for Second Vehicle Tunnel Under Hudson River

A bill introduced in the New York State Legislature provides for the construction of a second vehicle tunnel under the Hudson River connecting New York with New Jersey, at about 125th St. in the Borough of Manhattan, New York City. Under the bill the new tunnel would be planned and its construction directed by joint action of the existing Interstate Tunnel Commission of New York State and the representatives of the State of New Jersey or of any properly constituted authority thereof. This bill responds to a certain amount of agitation in favor of a tunnel in the vicinity of the location described, which has been carried on during the past year. An appropriation of $1,000,000 toward the construction of the tunnel is carried by the bill. As in the case of the Canal St. tunnel, now under construction, all expenditures are to be shared equally by the two parties, and the completed tunnel is to be operated by the commissions as a toll tunnel. The tunnel is to be for the exclusive use of pedestrians and vehicles not operated by public service corporation.

Long Beach Reconstructing Sewage Screening Plant

Long Beach, Calif., has awarded a contract to the Water Supply Co. for the thorough repair of the existing Reinsch-Wurl screen and the installation ahead of it of another screen of the drum type to increase the capacity of the screening plant. These changes are preliminary to the installation of additional pumps of larger capacity, which, however will not be begun until the present disposal plant is reconstructed. Two results are to be accomplished by the present work, namely, the renewal of the badly worn screens which are now in service and the increase in the capacity of the plant by the use of the drum screen which is expected to remove the greater portion of the solids, leaving only suspended matter to be handled by the Reinsch-Wurl screen. During the repairs a bypass to be constructed around the plant will temporarily deliver the sewage to the ocean outfall. No extension of the outfall is contemplated at present.

Engineers Chosen for Kansas City Water-Works Extension

After considerable delay in the additional water-supply project for Kansas City, Mo., due to a court decision that the non-partisan water board was illegally created and the reversion of the control of the works to the fire and water board, the latter board has appointed George W. Fuller, of Fuller & McClintock, New York City, and Alexander Maitland, president of the Kansas City Bridge Co., as engineers for the new supply. Mr. Maitland was chairman of the non-partisan water board. Fuller & McClintock made a detailed report on water-works enlargements for Kansas City about two years ago and on April 4, 1922, water bonds to the amount of $11,000,000 were authorized by a 4 to 1 popular vote. (See *Engineering News-Record*, Oct. 28, 1920, p. 865, April 13, 1922, p. 626 and Dec. 21, 1922, p. 1089.)

Views of Coal Commission Begin to Take Form

Small Danger of Price-Control by Combination—Storage Seen as Important Factor

Washington Correspondence

Competition is so rampant in the production of coal that price control hardly would be within the range of probability, even were the operators inclined to attempt it. That the President's coal commission has reached that conclusion was clearly deducible from statements by Chairman Hammond and Commissioner Smith. For the next few weeks, the commission, would concentrate much of its attention on anthracite matters. It is clear also that the commission is not in sympathy with the agitation for an embargo on anthracite exports; that its sentiment is stronger than ever against the railroad practice of commandeering coal and that certain coal rail-rate structures need to be scrutinized carefully.

Price Control

The comment as to price control followed a statement by Chairman Hammond to the effect that the commission intends to study coal prices over a period of several years. Mr. Hammond predicted that certain economies would be recommended, which will have an effect on prices, but he said there is no evidence that producers ever have considered any combination with the idea of bringing about higher prices for coal. On the contrary, he said, there is plenty of evidence of competition of the cut-throat variety. Dr. Smith added the opinion that, were operators to agree on a price for coal, some one of them would cut the price before he had been an hour out of the meeting. These points were emphasized to make it clear that the commission's exhaustive study of prices has as its objectives things other than the uncovering of a price-fixing conspiracy.

Chairman Hammond called attention to the far-reaching effect of railroad rate schedules on the coal problem as a whole. He was careful to point out, however, that the commission recognizes the Interstate Commerce Commission as the specialist on these matters and that no recommendation with regard to rate structures will be made until full advantage has been taken of the views of that body.

Importance of Storage

Chairman Hammond admitted that the importance which he attaches to storage amounts almost to an obsession. He strongly commended the public utility companies for the progress that they have made in establishing a policy whereby most of their plants provide ample storage reserves. Inducements will have to be held out, he said, to encourage such a policy among the small consumers, but the commission expects to find a way that will result in large storage on the part of the railroads. He pointed out in no uncertain terms that there is no such thing as a "right" whereby railroads commandeer coal. It was revealed that Governor Marshall calls this practice "stealing." Other references made to coal commandeering indicate that sentiment against it is well crystallized among the commissioners.

Construction Division Men Resent War Fraud Charges

Former Officers Pass Resolutions Protesting Action as Treason Against an Industry

At a meeting held in New York last week of former officers of the Construction Division of the Army, a resolution was passed in which it was stated that the recent indictments against former officers of the United States Army and bills in equity against former war time contractors were considered as being directed as well toward the entire Construction Division of the Army charged with actual execution of the contracts.

The full resolution follows:

"Resolved that, the Construction Division Association is composed of engineers, architects and members of professions related to construction who volunteered for service during the war and were assigned to the Construction Division of the Army. This division was intrusted with the great task of building camps in time to train troops to get to France.

"Charges have been made in civil and criminal proceedings of treasonable conspiracy to delay and obstruct this work of vital necessity, and to defraud the government. Charged as we were with the execution of this work no such conspiracy could have existed without our knowledge. No such conspiracy could have moved one step without our connivance and active aid.

"INDICTMENT OF TREASON"

"The indictment is an indictment for treason of the 1,500 officers and the thousands of men who were entrusted with this work. It is an indictment of the capacity of the nation in the time of its need to draw from the ranks of the technical professions and the construction industry a body of men who will not knowingly betray their country.

"In the mind of a large part of the public, not directly acquainted with this task, there has existed a complete misunderstanding of the facts as to the contracts under which work was done.

"At the outbreak of the war it was found that to wait until specifications could be drawn and detail plans worked out for the great cities that had to be built to house and train our troops would intolerably hold us back from fighting in the war.

"In this situation the ordinary peace time method of contracting could not be used. It is frequently said and believed that in this exigency contracts were made for construction under which the contractor was to receive as profit 10 per cent on all expenditures made, so that the higher the cost the greater the profit.

"Such contracts were in fact made by some governmental agencies, but not by the Construction Division of the Army. The contracts which are being attacked all contained a limitation on the amount of the fee to be paid. In the sixteen national army cantonment contracts the maximum fee was reached long before the work was completed and the gross profit on the whole work ran between 2 per cent and 3 per cent.

"The contracts gave the Construction Division control over the work, which, if we did our duty, required us to terminate the contract if the work were not done as efficiently and economically as the urgency permitted. We believe this was done. We know we gave all that was in us to perform this task. We believed that speed meant thousands of lives and that our Government and our civilization were in jeopardy.

"Accepting as we do these charges as equally directed at us, through whom the whole construction industry contributed its co-operation in the war, we resent them as a charge of treason.

"And be it further resolved that copies of this resolution be sent to the President of the United States, the Attorney General of the United States, the Chairman of the Senate Judiciary Committee and the chairman of the House Judiciary Committee."

A.A.E. Directors Condemn Cantonment Suits and Indictments

At its meeting Feb. 19-20, 1923, at Chicago, the board of directors of the American Association of Engineers passed the following resolution:

"Whereas; It has come to the attention through the press and in other ways that indictments have been presented and suits instituted against a number of contractors and others who built the various camps and cantonments during the war, and

"Whereas, The charges in the indictments, while general, are monstrous, in degree laying under heinous stigma not alone the defendants named but by implication many leading engineers and others engaged in the construction industry generally, who gave unselfishly of their time and skill towards the solution of handling the vast undertaking that confronted the United States at the opening of the war; therefore,

"Be it resolved by the A.A.E. that common justice demands immediate trial of these suits be brought, that these defendants, if innocent, may not longer rest under the odium of the grave charges and the good name of the engineering profession and those in the construction industry be cleared of any charge to conspire to defraud the government, and that copies of these resolutions be sent to the President of the United States, the Attorney-General, and the presiding officers of the Senate and House of Representatives."

Corrects Arguments in Am. Soc. C. E. Federation Ballot

As chairman of the committee of the Board of Direction of the Am. Soc. C. E. appointed to prepare the arguments against that society's joining the Federated American Engineering Societies, C. M. Holland has written to Gardner S. Williams in reply to a criticism by the latter concerning a statement in those arguments. Mr. Holland corrects an inaccuracy in the statement as to the traveling expenses incurred by the Federation. The figure given was $15,000 for 1922, whereas it should have been $16,445.74 for the past two years. He explains that the statement was made in good faith based on information believed to be trustworthy, and points out that the favorable arguments also are misleading on this point, in that they lead to the inference that only $6,600 was spent for travel during 1922, whereas the statement of the Federation shows that $8,417.65 was spent for that purpose.

Ohio Engineers Convention Supports Pending Bills

Included in important action taken at the forty-fourth annual convention of the Ohio Engineering Society held at the New Southern Hotel, Columbus, Feb. 8 and 9, was a resolution unanimously favoring Senate Bill No. 84 which provides for the registration of all engineers employed on public work. It was urged that such registration would raise the standard of the engineers so employed. Another resolution was unanimously adopted favoring House Bill No. 183 extending the tenure of county surveyors in Ohio from two to four years. The bill does not affect present officials, nor does it raise salaries.

Two other bills were given unanimous support: the public health bill, permitting municipalities or other political sub-divisions to make assessments on property to carry out sewage projects which have been approved by voters; and the bill proposing a tax of 1½ cents per gallon on all gasoline sold in Ohio, the proceeds to be used for road purposes.

Among convention speakers were: Clifford Older, state highway engineer of Illinois, who gave an interesting talk on "The Bates Road Test"; C. B. Cornell, construction engineer on the Columbus Storage Dam project, who told of the progress of that work; R. N. Begien, general manager of the B. & O. RR. at Cincinnati, who spoke on railroad transportation; John Laylin, assistant director of highways and public works, stationed at Norwalk; Glenn R. Logue, chief engineer of the bridge department, Ohio Highway Commission; T. Glenn Phillips, consultant to the city planning commission of Detroit; and W. D. McKinney, secretary of the Southern Ohio Coal Exchange.

Officers for the coming year were elected as follows: John Leech, Steubenville, president; E. A. Lawrence, Columbus, vice-president and John W. Graham of Chillicothe, secretary-treasurer. The latter was re-elected while Mr. Leech succeeds Robert M. Waid of Columbus.

Sir Henry Thornton Names Executives for C.N.R.

Sir Henry Thornton, president of the Canadian National Railways, has announced the following appointments: S. J. Hungerford, vice-president in charge of operation and maintenance; W. D. Robb, vice-president in charge of natural resources, development and colonization, also express and telegraph departments; Major Graham A. Bell, vice-president in charge of finance; Gerald G. Ruel, vice-president and general counsel; R. C. Vaughan, director of purchases and stores.

Mr. Hungerford has had a long experience in railway affairs. He was born in Bedford, Que., in 1872 and 22 years ago joined the staff of the C.P.R., becoming superintendent of the C.P.R. shops and afterwards master mechanic of the Western Division. In 1910 he joined the Canadian Northern Ry. on which he held several important positions, and when the line was taken over by the government he became in 1920 vice-president over operating and maintenance, and later designated as acting president.

Metropolitan District of Chicago to Be Discussed

A metropolitan planning conference to discuss the development of the Chicago metropolitan district has been called for March 3 at the City Club of Chicago. Mayors of 14 cities, presidents of villages, chairmen of official boards and commissions, and representatives of civic and commercial bodies are included in the call. A comprehensive plan for the district extending from Waukegan to Gary is proposed and a permanent planning commission may be created. A survey is proposed to cover the industrial, commercial, civic, social, sanitary and governmental problems. Indicating the need is the statement that there are more than 300 local taxing governmental units, 14 cities, 83 villages, 191 school districts, 29 townships and 31 park districts. No less than 98 boards or engineers are independently planning and constructing sewers, 119 street or engineering departments are laying out and paving streets, highways and boulevards, 94 legislative bodies enact ordinances and regulate local transportation.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Annual Convention, Chicago, March 13-15.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29 or 30.

The San Francisco Engineers' Club on Feb. 14 listened to an address by E. J. Mehren, editor of *Engineering News-Record*, on "Impressions of the Present Trend In Engineering Progress."

The Colorado Society of Engineers at its recent annual meeting elected the following officers: President, W. M. McMechen; vice-president, F. C. Steinhauer; secretary-treasurer, C. M. Lightburn.

The Colorado Engineering Council recently elected the following officers for 1923: President, Prof. L. G. Carpenter; vice-president, R. W. Gordon; secretary-treasurer, C. M. Lightburn. The Colorado Section of the American Chemical Society was admitted to membership, making twelve member organizations.

The Wyoming Society of Engineers has elected the following officers: President, J. W. Wisda; vice-president, Z. E. Sevison; secretary-treasurer, H. G. Matson, Cheyenne.

The Denver Chapter American Association of Engineers, Feb. 5, elected officers as follows: O. F. Reedy, assistant state highway engineer, president; R. D. Hubbard, assistant engineer of the state reclamation service, vice-president; P. W. English, manager of the Denver Blue Print and Supply Co., secretary; V. F. Whitmore, office engineer for the Union Pacific R.R., treasurer.

Personal Notes

A. C. LINGLEY, who has been division engineer for Division 4 of the Missouri State Highway Dept., with offices in Kansas City, since last Spring, has been appointed construction engineer for the Highway Department with offices at Jefferson City. His successor is W. M. SPANN, who has been acting construction engineer of Jefferson City.

ROLLIN J. WINDROW has resigned as consulting engineer for the Missouri State Highway Commission and personal representative of Theodore Gary, chairman of the commission, to devote his time to personal business. Mr. Windrow is connected with the firm of Smith Bros., prominent general contractors of Dallas, Texas.

THOMAS E. MITTEN has resigned as president of the Philadelphia Rapid Transit Co. He will remain with the company as chairman of the board of directors in which capacity he will have charge of negotiations between the company and the city with regard to the operation of city-built rapid transit lines.

J. ROWLAND BIBBINS has resigned as manager of the transportation department, Chamber of Commerce of the United States, to engage in consulting practice in transportation and its related economic and civic problems, including traffic surveys, railway terminal and transit developments, valuations and franchise arbitrations, and transportation aspects of city planning work. Mr. Bibbins was previously associated with the Bion J. Arnold Engineering Association of Chicago, and in this work studied intensively the transportation problems of some twenty cities of the United States and Canada with regard to rapid transit, railroad and port terminals, civic development, valuation, and the economic policies involved therein. During the two years he has been in Washington he has devoted special study to the whole group of transportation agencies—railway, traction, highway, waterway, airway, and marine, and their relative status and possibilities of co-ordinated development. Mr. Bibbins will make his headquarters in Washington, D. C.

J. WALDO SMITH, consulting engineer and formerly chief engineer of the New York Board of Water Supply in charge of the construction of the Catskill aqueduct, left New York on the "Adriatic" Feb. 24, for a two months' trip to Europe. He will arrive at Naples March 12 and after visits to Rome and other Italian cities, will go to Switzerland, France, Belgium, and England, returning to New York early in May. JOHN H. COOK, hydraulic engineer, East Jersey Water Co., and F. B. ROGERS, of George W. Rogers & Co., were passengers with Mr. Smith.

W. L. THOMPSON has opened an office in the Weinberg Building, Greenville, Miss., for the general practice of civil engineering. Mr. Thompson has had a wide experience in flood control, drainage and related works, highways and foundations, as well as an intensive service of over eight years in the most active period of Panama Canal.

E. B. PARSONS, who has been associated with E. G. ORBERT at Milwaukee, Wisconsin, has opened an office at Jefferson, Wisconsin, where he will practice municipal engineering. Mr. Orbert will maintain an office at Milwaukee.

OSCAR CLAUSSEN, who retired from the position of city engineer of St. Paul the first of the year, after fourteen years' service, and J. E. CARROLL, assistant city engineer for the last eleven years, have formed the Claussen & Carroll Engineering Co. and opened offices at 406 Metropolitan Bank Bldg., St. Paul. They will engage in general service as consulting engineers, including waterworks, sewers, paving and power plants, and valuations.

HOMER M. MATTHEWS, until recently office engineer for the Mexican Light & Power Co. of Necaxa, Pueblo, Mexico, is now engineer of the bridge department of the Texas State Highway Department.

JAMES G. RONEY is now assistant in the engineer corps, Eastern Division, of the Pennsylvania R.R. Co., having but recently left the Texas & Pacific Ry., where he was employed as assistant engineer.

A. G. BRIGGS, until recently resident engineer with the North Carolina State Highway Commission, has entered private practice, being located at Locust Dale, Va.

PHILIP O. MACQUEEN, until recently assistant engineer with the Frazier-Ellms-Sheal Co. of Cleveland, has opened offices in Washington, D. C., for the practice of civil engineering. He will pay particular attention to water-supply purification, sewerage and sewage disposal, and real estate developments.

HERBERT E. ROSS is now inspector in the construction division of the New York Telephone Co., Brooklyn, N. Y., having but recently left the J. J. Guinan Contracting Co., where he was employed as superintendent of construction.

JAMES M. ANGLE is now highway bridge engineer with the U. S. Bureau of Public Roads and stationed in Washington, D. C., having but recently left Pittsburgh, Pa., where he was employed as a special draftsman in the Allegheny County engineer's office.

B. E. BUSHNELL, formerly a structural designer and detailer with the Ingalls Iron Works of Birmingham, Ala., has become associated with the U. S. Engineer's Office at Florence, Ala. He is a junior engineer employed on the construction of the Wilson dam.

RUSSELL D. WELSH is now a resident engineer stationed in Elizabeth City, N. C., for William C. Olsen, consulting engineer of Kinston, N. C. He was formerly with the firm of George R. Morris of Baltimore, Md.

J. ROSCOE SHARP, formerly employed in various capacities with Stone & Webster, Inc., engineers and contractors, Boston, has joined the U. G. I. Contracting Co. of Norristown, Pa. Mr. Sharp's position is that of office engineer.

JOHN D. CRUISE, who for some time past has been employed in the bridge department of the North Carolina State Highway Commission, has become associated with the Michigan State Highway Department, where he is employed in similar work.

G. E. HESSELBACHER has become a partner in the engineering and contracting firm of Hesswin Co., Elkins Park, Pa., Mr. Hesselbacher formerly was engineer with the U. G. I. Contracting Co. of Philadelphia.

L. J. SVERDRUP, until recently a designer in the Minnesota State Highway Department, has become assistant bridge engineer for the Missouri State Highway Department.

Obituary

CAPT. H. C. C. WALKEM, M. C., died at Gananoque, Ont., February 8, after a brief illness. Capt. Walkem graduated at the Royal Military College, Kingston, Ont., and during the war served with the Royal Engineers of the Imperial army, being awarded the military cross as a recognition of distinguished service. Since the war he has been engaged on engineering work with the Department of Public Works.

GUSTAVE KAUFMAN, consulting engineer, contractor and a prominent figure in the development of the Ferris wheel, died recently in New York, aged 64 years. After graduation from Rensselaer Polytechnic Institute in 1880 Mr. Kaufman was engaged in railroad work, being first employed by the Pennsylvania R.R. Co. Five years later he was made chief engineer with the Pittsburgh & Western R.R., now part of the B. & O. Later he formed a consulting engineering partnership with G. W. G. Ferris under the firm name of G. W. G. Ferris & Co. Mr. Kaufman entered the contracting business in New York about 25 years ago, some of the important work he handled having been the Brooklyn piers of the Manhattan Bridge, Atlantic Avenue subway, and various structures on Staten Island and Long Island.

MERRILL WATSON, one of the pioneers in concrete and fireproof construction work, died last week at his home in East Orange, N. J., aged 72 years. One of the first fireproof buildings erected in New York City was constructed by Mr. Watson. He was a graduate of Ohio Wesleyan University, thereafter entering newspaper work. For thirteen years he served as editor and manager of *Age of Steel*, of St. Louis. After leaving technical editorial work he became interested in expanded metal, and for ten years was manager and treasurer of the N. Y. Expanded Metal Co., and secretary and treasurer of the Associated Expanded Metal Companies.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Test Liquid Oxygen for Blasting Purposes

Adolph Messer, German Manufacturer, Demonstrates Method at West Virginia Quarry Before Federal Officials

LIQUID oxygen as a blasting explosive was given its first public demonstration in the United States on Feb. 7 at the quarry of the Kelley Island Lime & Stone Co., near Martinsburg, W. Va., when Adolph Messer, head of the German firm of Messer & Co., conducted tests under arrangements made by the U. S. Bureau of Mines. George S. Rice, the Bureau's chief mining engineer, attaches great significance to the Martinsburg tests as showing that liquid oxygen may be successfully used in deep holes—16 to 20 ft. An appropriation will be available July 1 for a further study of liquid oxygen explosive by the Bureau of Mines.

In line with these developments announcement has just been made that a liquid oxygen explosive plant is now being completed at the iron mining property of the Witherbee-Sherman Co. at Mineville, N. Y., and will be placed in service in the mining operations of the company within a few weeks. This is the first commercial plant to be built by a newly formed organization in which the Air Reduction Co. and the Ingersoll-Rand Co. will co-operate.

The liquid oxygen explosive is made by soaking sticks of carbon in liquid oxygen on the spot where blasting is to be done. The holes are then loaded with the saturated cartridges as quickly as possible and blasting follows with a minimum loss of time, as the oxygen evaporates rapidly. Most of the cartridges used in the Martinsburg test were 40 x 300 mm., each containing 75 grams of pure lampblack. Immediately after soaking they weighed about ¾ lb. each, indicating a ratio of absorption of about 3½ to 1. The program included the blasting of one round of two holes, one round of three holes, one block shot, and two mud caps. The holes were 16 and 20 ft. deep.

The results of these tests and other recent developments indicate that the practical application of oxygen to blasting operations is beginning. It is understood that orders have been placed for more than fifty of the German machines, most of these, however, being in plants where oxygen is used in welding operations.

PORTLAND CEMENT ASSOCIATION has opened offices in New Orleans, with John E. Tate as district engineer. He will have supervision of Louisiana and Mississippi. Mr. Tate comes from the Atlanta office of the association, where he was field engineer. Prior to this he was resident engineer of the Maryland State Roads Commission and served also with the Delaware State Highway Department as assistant engineer.

To Increase Production of Pipe Cast by Centrifugal Process

The United States Cast Iron Pipe & Foundry Co., Burlington, N. J., is more than doubling the capacity of the unit for the manufacture of deLavaud centrifrugal pipe at its North Birmingham, Ala., works.

The original unit, consisting of four centrifugal machines, making 6, 8, 10 and 12-in. pipe, was placed in operation in August, 1922. On account of the increasing demand for this pipe it has been found necessary to add five more machines, which it is expected will be in operation by midsummer.

In addition to the pipe manufactured by the U. S. company, the National Cast Iron Pipe Co. of Birmingham, Ala., also has a license for the manufacture of centrifugally cast pipe, and expects to have in operation by midsummer an entirely new plant, consisting of four or more machines, with the necessary annealing ovens.

The U. S. Cast Iron Pipe & Foundry Co. is now working on plans for a new unit to be erected in connection with its Burlington, N. J., works, which will consist of ten machines.

Lumber Associations Merge

A merger of the National Wholesale Lumber Dealers' Association and the American Wholesale Lumber Association has been recommended by a joint committee of the two bodies and approved by their boards of directors. To this end both organizations are planning to hold their annual meetings in Pittsburgh, March 21 and 22, at which time the membership of both associations will be asked to ratify the action of their respective boards, thus bringing into existence a new wholesale lumber association with a membership of about 700. The enlarged organization is to be known as the National-American Wholesale Lumber Association, with headquarters in New York City and a branch office in Chicago.

L. R. Putnam, directing manager of the American Wholesale Lumber Association, has resigned and will not be connected with the merged association. On April 1 he will become a member of the Ferry-Hanly Advertising Co. at Chicago, as head of the building materials department, which handles several important accounts, including the Southern Pine Association, the Long Bell Lumber Co., and others.

To Co-operate in Manufacture of Electric Locomotives

The General Electric Co., Schenectady, N. Y., and the American Locomotive Co., New York City, announce that they have entered into an arrangement providing for close co-operation between the engineering organizations and manufacturing facilities of the two companies in the design and manufacture of electric locomotives for use on steam or electric railways.

Pelton Wheel Tests Show High Efficiency

Tests on the 20,000 hp. Pelton single overhung reaction turbine at Cedar Falls Extension Plant of the City of Seattle have just been completed. This plant was placed in service in June 1921, but for reasons beyond the control of either the city or the manufacturer, final testing was delayed until a few days ago. Notwithstanding having been in service for more than a year and a half, the unit was found to be in perfect operating condition the absence of vibration being particularly noticeable. Water measurements were made by a weir installed permanently as a part of the power plant equipment. A satisfactory efficiency curve was obtained, the maximum exceeding 92 per cent.

To Reduce Varieties of Doors and Window Sashes

AS the result of a conference held Feb. 20 under the auspices of the Division of Simplified Practice of the U. S. Department of Commerce, representatives of the millwork industry, expressing the opinion that approximately 30 per cent of the sizes of doors and window sashes now made could be eliminated, decided to submit the suggestion to the manufacturers in May. If the proposal is approved a survey of the industries affected will be made to determine the percentages of the various types and sizes manufactured during the last three years so as to determine those in least demand.

This conference was the outgrowth of one held in February, 1922, by architects, builders and engineers regarding dimensional simplification of building materials, the subject of millwork subsequently having been considered by the major associations of the industry.

Reasons for Variations

N. L. Godfrey, secretary of the Wholesale Sash & Door Association, explained the reasons for the variations in demand as existing in the different sections of the country, due to weather conditions, tradition and other factors. He stated that panel doors are made in 35 sizes, sash doors in 10 sizes, French doors in 15 sizes and window sashes in more than 200 different sizes. He expressed the opinion that there is considerable room for simplification.

W. A. Durgin, chief of the Division of Simplified Practice; Dr. John M. Gries, chief of the Division of Building and Housing; and E. W. McCullough, manager of the Fabricated Production Department of the Chamber of Commerce of the United States, explained the benefits of simplification and standardization within their experience. The representatives of the industry engaged in a general discussion of the subject. It is probable that whatever is done in this field will be undertaken as a sectional proposition, due to the varying demands of the different parts of the country.

Among others attending the conference were: W. H. Ham, Bridgeport Housing Co.; S. W. Jones, American Institute of Architects; Joseph N. Harding, Chas. Filen & Co.; E. J. Curtis, Curtis Companies, Inc.; E. F. Hunt, Eastern Wood Workers; and John H. Derr, Sash & Door Manufacturers Association.

Allied Machinery Co. to Manage Domestic Sales

The Allied Machinery Co. of America, which has hitherto confined its activities to export trade, has taken over the management of the sales in New York City and vicinity of the Clyde Iron Works Sales Co., Duluth; the Austin-Western Road Machinery Co., Chicago; the Austin Manufacturing Co., Chicago; the Lakewood Engineering Co., Cleveland; and the Universal Crane Co., Elyria, O. The company, in its domestic business, will follow the same methods used in building up the export trade of these and other important American manufacturers of construction machinery and equipment. S. T. Henry, vice-president of the Allied organization, will direct the new sales program.

Men from the factories of the manufacturers named above will be resident in New York City to give customers expert service. Stocks of machinery and equipment will be maintained in New York to insure prompt deliveries. Repairs also will be carried in stock.

Offices will be continued at the Allied Construction Machinery Center, 139-149 Center St., New York City, where these manufacturers and several others have, for some years, maintained the largest permanent exhibit of this kind of machinery and equipment ever undertaken.

Standardization and Simplification

From the report of the Committee on Methods presented at the annual convention of the Associated General Contractors in Los Angeles, Cal., Jan. 30-Feb. 3.

The elimination of unnecessary varieties of materials and the simplification of dimensions is being urged by your committee wherever such standardization appears practicable. Your association, through Noble Foster Hoggson, of Hoggson Bros., is represented in the Division of Simplified Practices, U. S. Department of Commerce, which is making special studies of mill work, plumbing, heating, interior wall construction, hardware, lighting fixtures and clay products. Considerable progress has already been made in eliminating sizes and varieties. The association is also represented on the special committee of the American Engineering Standards Committee to approve and sponsor future developments in the field of standards. Membership is also held on the advisory board of the Bureau of Mines to consider the question of treatment of drill steel and on the consulting committee of the Central Lumber Standards Committee, which is the council of manufacturers and consumers of lumber actively carrying out the establishment of standard sizes and quality.

The efforts of different associations in the field of standardization have become fairly well co-ordinated, so that there is little duplication of effort, and within the next year or so the practical application of many standards in the basic industries supplying construction will have been put into effect. Your association has taken an active part in this work and has received a gratifying measure of recognition in the national councils of industry.

D. A. Decrow, Waterworks Pump Specialist, Dies

As Manager With Worthington Corp. He Designed and Installed Plants in Largest Cities of U. S.

DAVID A. DECROW, manager of the waterworks department of the Worthington Pump and Machinery Corp., New York, died in East Orange, N. J., Feb. 15. He designed and installed waterworks pumping machinery for many of the largest cities in the United States, including Buffalo, Detroit, St. Louis, Columbus, Cincinnati, Louisville, Boston, Cleveland and Philadelphia.

Born in Bangor, Me., in 1859, he was graduated from the college of mechanic arts, University of Maine, in 1879 and taught school for a year or more in a lumber camp in Maine. While in college he was prominent in athletics and as pitcher of the university baseball team, was one of the first to use a curved ball.

He went from Maine to Lockport, N. Y., in the early '80s and became associated with the Holly Manufacturing Co. as a mechanical draftsman. Here his engineering and business ability was evident from the start and his promotions were rapid. In 1893 he was made designing engineer, in 1900 chief engineer, and in 1903 secretary of the Holly company. During his connection with that plant he built up a national reputation as a waterworks engineer continued as a specialist in that line to the time of his death.

Some years ago the Holly Manufacturing Co. was combined with the Snow Steam Pump Works at Buffalo, New York, as part of the International Steam Pump Co. Mr. Decrow went to Buffalo at the time of this change and took charge of the pumping machinery manufactured by both companies.

The International company was succeeded by the Worthington Pump and Machinery Corp. in April, 1916. Soon thereafter Mr. Decrow was called to the head office of the Worthington in New York as manager of the waterworks department and continued in this position until his death. It is significant that he remained with what was, to all intents and purposes, the same organization from the time he began his professional work until the close of a successful career.

Mr. Decrow was active in the affairs of the American Society of Mechanical Engineers and chairman of the committee for the revision of test code for reciprocating displacement pumps. He had been president of the Buffalo Club, President of the Park Club at Buffalo, and member of the American and the New England Waterworks Associations.

Slag Association Meets

At the fifth annual meeting of the National Slag Association in Cleveland, Feb. 16, officers elected were:

President, C. L. McKenzie, Duquesne Slag Product Co., Pittsburgh; vice-president, C. E. Ireland, Birmingham Slag Co., Birmingham; secretary-treasurer, H. J. Love, Cleveland.

At the afternoon session A. T. Goldbeck, chief, Division of Tests, U. S. Bureau of Public Roads, discussed with the producers the investigation of slag as an aggregate in concrete which the Bureau has practically completed.

Claim Infringement in Placing Concrete Pneumatically

Alleging infringement of patent rights, the Concrete Mixing & Conveying Co., Chicago, has brought suit against the Ulen Contracting Corp. for the use of the Cox-Webb pneumatic placing machine on the Shandaken tunnel of the Catskill Aqueduct for New York City's water supply. This tunnel, on which the last pair of headings was holed through on Feb. 13, is the longest in the world, covering 18.1 miles. It has a finished section 10 ft. 6 in. by 11 ft. 3 in. and will be lined throughout with concrete.

Steel Locker Manufacturers Plan Reduction of Varieties

As the result of a preliminary conference with officials of the Division of Simplified Practices of the U. S. Department of Commerce, manufacturers of steel lockers have appointed a committee to survey the industry and report at a subsequent meeting on the practicability of eliminating some of the sizes which now are supplied.

It was stated at the conference that more than 100 sizes of lockers are being manufactured and the representatives present agreed that this number is considerably in excess of real needs. Style of lock, ventilation and other features, it was stated, have more influence upon sales than minor variations in sizes.

The committee on survey will not only canvass the situation among manufacturers and distributors but will take up the subject with architects and others who control specifications. C. S. Berger of the Berger Manufacturing Co., Canton, Ohio, was chosen chairman of the survey committee.

Business Notes

SAUERMAN BROS., Chicago, manufacturers of dragline cableways and power scrapers, announce the consolidation of the various departments of their business at 426-440 South 10th St., where the warehouse and shop are located. The general offices will be moved to the new location from the Monadnock Block, where they have been maintained for seventeen years. The company recently appointed as its agent Alfred J. Forschner Co., Philadelphia, for the territory in eastern Pennsylvania, Delaware, and Maryland. Provision has been made also for the carrying of a complete stock of repair parts by three Pacific Coast equipment dealers: Smith, Booth, Usher Co., Los Angeles and San Francisco; Feenaughty Machinery Co., Portland, Ore.; and the Pacific Derrick & Hoist Co., Seattle, Wash.

KANSAS CITY BOLT & NUT CO., Kansas City, Mo., announces the election of W. L. Allen, formerly vice-president and general manager of the Laclede Steel Co., St. Louis, as its president, effective Feb. 1. George T. Cook, who has served for some time as chairman of the board, becomes chairman of the executive committee. Solomon Stoddard, who has been active head of the company as its president for a number of years, becomes chairman of the board.

HUBBARD-FLOYD CO., New York City, has been appointed as distributing agent for the cranes manufactured by the Northwest Engineering Co., Chicago. Stocks of repair parts will be kept on hand to provide for a 24-hr. service.

EUGENE D. WILLIAMS, formerly purchasing agent of the city of San Diego, Cal., heads the Williams-Black-Penn Co., a new organization in that city, selling agents for pipe, tanks, culverts, water meters, etc., with offices at 425 A St.

JOSEPH T. RYERSON has been elected president of Joseph T. Ryerson & Son, Inc., manufacturers of iron, steel and machinery, succeeding Clyde M. Carr, who, on account of ill health, has been unable to take an active part in the management of the organization for the past two years. Mr. Carr, who entered the service of the Ryerson company in 1890, will continue as a director. The newly elected president is

J. T. RYERSON

CLYDE M. CARR

the grandson of the company's founder, Joseph T., and brings to his duties a background of 22 years in the steel business. Born in Chicago in 1880, he was graduated from Yale in 1901 and went to work for the American Sheet Steel Co., now the American Sheet & Tin Plate Co., at its mill in Vandergrift, Pa. In October, 1902, he started with the Ryerson organization at Chicago and in 1904 was elected treasurer. He became vice-president of the company in 1911.

JOSEPH A. BOUCHER was appointed sales manager of Gifford-Wood Co. at a recent meeting of the board of directors of that organization. Mr. Boucher for more than fifteen years has served the company, first in its office at Hudson, N. Y., and eventually joining the sales force, later being asigned to the New York office. Mr. Boucher will be located at the company's main office in Hudson. The Gifford-Wood Co. are manufacturers of elevating and conveying machinery, ice tools, etc.

L. D. GRISBAUM, formerly district manager of the Dravo-Doyle Co., Indianapolis, has left that position to become the vice-president and active head of the Dravo Equipment Co. This is a new corporation, organized for the sale of construction and road builders' equipment, with general offices in New York, Philadelphia, Chicago, and Cleveland. Among others, this new selling organization represents the Marsh-Capron Co., manufacturers of concrete mixers, and the Hotchkiss Steel Products Co., manufacturers of steel forms for concrete road, sidewalk, curb and gutter construction.

LESLIE GARLINGHOUSE has been transferred from the main office of the Blaw-Knox Co. in Pittsburgh to the Birmingham, (Ala.) office. There he will act as sales engineer in assisting the Birmingham manager, P. V. Kelly, and will co-operate with the Southern agencies which are handling Blaw-Knox products.

L. V. WALSH, for twenty years treasurer and general manager of sales of the Pittsburgh Shovel Company, Pittsburgh, has resigned. C. B. STEFFY, since 1917 secretary of the company, has been appointed general manager of sales, and also retains his office as secretary.

H. J. KRANZ has been appointed as of Jan. 1, assistant general manager of sales of the Laclede Steel Co., with headquarters in St. Louis. Until his connection with Laclede company early in 1922 he was the Kansas City representative of Carnegie Steel Co., Tennessee Coal, Iron & Railroad Co. and Illinois Steel Co.

S. R. TYLER has been elected secretary of the Laclede Steel Co., St. Louis, Mo., effective Jan. 1. His first connection with the steel industry was with the Republic Iron & Steel Co., at Moline, Illinois, and afterwards at the various other plants of the Republic company throughout the country. He was later employed in the operating department of the Laclede Company, and in 1917 was made purchasing agent.

H. L. HURST who has been assistant general manager of the General Motors Truck Co., Pontiac, Mich., has been elected vice-president of the company, according to an announcement today by W. L. Day, president and general manager. Mr. Hurst has been with the truck company for the last 10 years in various capacities. In his new position Mr. Hurst will be the second officer in charge of the truck company at the factory, while O. E. Stoll, manager of the New York branch and a vice-president of the company will continue in charge of the eastern territory.

H. E. MARKS CORP., manufacturer of gypsum roofs, Pittsburgh, Pa., announces the opening of a New York sales office at 18 West 34th St., in charge of E. P. Cadwallader, and of a new Philadelphia branch office at 703 Harrison Building, in charge of T. R. Galey.

W. H. WINTERROWD has resigned as chief mechanical engineer of the Canadian Pacific Ry. to become assistant to the president of the Lima Locomotive Works, Inc. Mr. Winterrowd's early railway service was with the Lake Shore & Michigan Southern, as assistant mechanical engineer, a position which he left in 1912 to join the staff of the C.P.R., as assistant to Chief Mechanical Engineer H. H. Vaughan.

G. LOISSEAU, the Paris distributor of GMC trucks in France, and W. L. Sherman, formerly General Motors Truck company export man at Paris, were among the visitors at the Pontiac, Mich., factory during the last week. M. Loisseau said that American trucks were coming more and more into preference abroad and predicted that as soon as tariff was revised by foreign countries sales would take a big increase.

Equipment and Materials

Hoisting Accidents Prevented by Closed Safety Hook

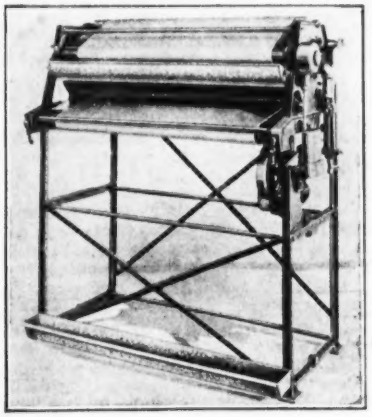
To insure safety in hoisting heavy loads with cranes or derricks on construction work a hook equipped with a locking device has been developed by the Yankee Safety Appliances Co., New York City. It is an adaptation of a device designed for detaching lifeboats from ships at sea. The locking principle of the hook is illustrated in the accompanying drawings. It cannot be attached to a load unless it is locked in position and cannot be unlocked until the load is safely landed and the hoisting line slack. The drawing at the left shows the hook locked and in position to carry a load; the one at the right indicates how the hook may be unlatched when the tension on the hoisting rope is released.

These hooks are made in five sizes with capacities respectively of 2, 5, 10, 15, and 25 tons. On the two larger sizes a handle is provided to facilitate the unlatching of the safety device. The bearing pins are of Monel metal. If desired, a ball-bearing swivel can be provided for the 20- and 25-ton sizes.

Blueprints Dried by Machine With Heated Copper Drum

In the new blueprint dryer perfected by the C. F. Pease Co., Chicago, as accessory equipment to its blueprinting and washing machines, wet sheets are drawn by an endless canvas belt around a heated copper drum, dried at the rate of 8 to 9 ft. a minute and delivered free from wrinkles. Before entering the machine the wet prints pass over a brass roll, which acts as a squeegee, and the traveling apron carrying the sheets is inclined slightly so that surplus water drains away. The dried paper, it is claimed, does not adhere to the copper cylinder, but peels off automatically.

A special feature of the equipment is a patented thermostatic control used when the dryers are heated with gas. When heated electrically the thermostat is replaced by a series of switches, enabling the operator to throw in sufficient current to maintain the proper temperature.



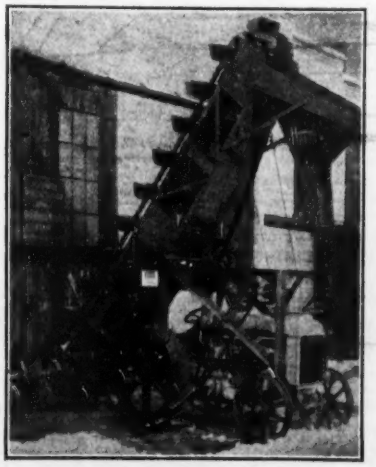
For centering the traveling canvas belt the same arrangement is employed on the dryer as has been in use on the Peerless continuous blueprinting machine. A hand-wheel on either side of the belt enables slight adjustments to be made quickly and accurately. To prevent high maintenance costs, due to the rotting of the canvas bands by constant wetting and overheating, an asbestos apron is provided with the machine. This apron is run into the machine and around the cylinder just before the motor is stopped, providing protection for the belt while the cylinder is cooling off.

The drying machine is suitable for widths of paper up to 42 in. Gear changes offer two ranges of speeds—8 to 9 ft. and 4 to 5 ft. of paper per minute. The equipment is operated by a ½-hp. motor.

Elevating Loader on Tractor

The latest design in truck loaders brought out by the George Haiss Manufacturing Co., Inc., New York, consists of a bucket elevator mounted with three-point suspension on a Fordson tractor, as shown in the accompanying photograph. The elevator is equipped with feeding propellers.

The mechanism is controlled by an operator occupying the driver's seat on the tractor, the elevator being driven from the side shaft on which is installed a sprocket connected by chain to a counter-shaft. A clutch makes possible the propelling of the machine without running the elevator. The tractor has a speed of 2 miles an hour backwards and three speeds forward of 2½, 5 and 8 miles an hour. The total weight of the equipment is 6,000 lb. The rig is intended for use in loading trucks or unloading hopper bottom cars at a number of widely separated points.



Publications from the Construction Industry

Spiral Riveted Pipe—AMERICAN SPIRAL PIPE WORKS, Chicago, has issued a new illustrated catalog and price list covering 75 p. In manufacturing this pipe a strip of sheet steel is wound into helical shape with one edge overlapping the other for riveting the seam, the latter process being done by equeezing under pressure and not by percussion or hammering. The several steps in the process of manufacture are described and succeeding pages illustrate notable installations of this pipe within the past 20 years for both high and low pressure. Several pages are given over to a collection of hydraulic tables and charts. A wide variety of special steel fittings also is illustrated. Reference is made to the company's more recently developed lines, including all types of forged steel flanges, large diameter forge welded pipe, and corrugated steel furnaces.

Hard, Dense Concrete — GENERAL CHEMICAL CO., New York, describe its Hard-N-Tyte engineering service for making concrete and stone resistant to wear, water and weather, in a 16-p. illustrated booklet. The foundation of this service is a metallic fluosilicate compound which is introduced into the water used in mixing the concrete. The material is not sold by the pound or barrel, but at a stated price per square foot for the particular result desired. As a general rule, it is stated, the cost does not exceed 3 cents per square foot.

Concrete Foundations — PORTLAND CEMENT ASSOCIATION presents data on the use of concrete for foundation walls and basement of houses in a 19-p. illustrated booklet just issued. The text deals with poured walls and walls built of precast block. Information is given regarding correct concrete mixtures, methods of construction and waterproofing. There are also tables indicating the quantities of material required.

Traction Ditchers—BUCKEYE TRACTION DITCHER CO., Findlay, Ohio, is distributing an illustrated booklet containing performance data on trench excavators. The general description of the Model C machine emphasizes the new rotary auxiliary cutter by means of which a variety of trench widths may be cut with a single machine.

Combined Shovel and Crane—PAWLING & HARNISCHFEGER CO., Milwaukee, in a 16-page illustrated booklet feature the versatility of its ¾-yd. power shovel and crane. By means of interchangeable booms the same machine may be put to eight uses—as a power shovel, a dragline, a clamshell or orange peel bucket crane, a backfiller, a piledriver, a block-and-tackle crane, a skimmer scoop.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

February Contracts Heavier Than Year Ago

More Than Double Value of Awards In Same Month Last Year—Number of Jobs Greater Also

Contracts awarded on important engineering projects in the United States and Canada totaled $123,742,000 for February, as against $142,599,000 for the preceding month, and $123,143,000 during December.

Deducting the Canadian awards for the month, valued at $1,377,000 and consisting mainly of streets and roads, year, are as follows:

Water-works — Thirty-one projects averaging $88,000, as against twenty-six with an average value of $181,000.

Sewers—Twenty-six contracts averaged $82,000, compared with twenty-three, averaging $144,000.

Bridges—Twenty-six jobs averaging $104,000, against thirty-one with an average value of $222,000.

Excavation, Drainage and Irrigation —Number of jobs the same, with average value smaller than in January.

Streets and Roads—Eighty-four projects averaging $223,000, as against 131 with an average value of $165,000.

Industrial Works — Ninety-seven awards with an average value of $95,000, compared with ninety-eight, averaging $253,000.

Buildings—Contracts for 145 averaging $536,000 each, against 162 averaging $41,000.

Federal Government Work—Twenty-three jobs averaging $177,000 compared with twenty-four with an average value of $229,000.

Miscellaneous — Thirty-six projects with an average value of $161,000, against twenty-four averaging $192,000.

Next week—Road programs of several other states, as per those given in this issue.

Engineering News-Record Construction Cost Index Number

March, 1923	**205.25**
February, 1923	197.40
March, 1922	162.04
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number advanced 7.85 points since last month, due to higher steel, lumber and cement prices, and stiffening in labor rates. Steel rose to $2.25 from $2.10 per 100 lb., Pittsburgh mill. The average rate for common labor is now 49c. Thus, general construction cost is 26 per cent higher than one year ago and 25 per cent under the peak; it is 105 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
February, 1923 (*4 issues of E. N.-R.*)	105
January, 1923 (*4 issues of E. N.-R.*)	126
February, 1922 (*4 issues of E. N.-R.*)	100
1913	100
Yearly	
1922 (entire year)	130
1921 (entire year)	88
1920 (entire year)	91
1913	100

Engineering News-Record's Construction Volume Index Number is 105 for the month of February, and 130 for the whole of 1922, as against 100 for 1913. This means that the actual volume of construction in 1922 (not the mere money-value of the contracts let that year) is 30 per cent above the volume of construction for 1913. Our monthly volume number, 105 for February, 1923, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

industrial works and buildings, leaves a total of $122,365,000 for entire U. S.

Although the February total shows a seasonal drop of 13 per cent in money value and over 12 per cent in number of projects from the preceding month, it also shows an increase of over 136 per cent in value and 45 per cent in number compared with the same month in 1922.

Minimum costs observed in Construction News on each class of construction are as follows: Water-works, $15,000; other public works, $25,000; industrial construction, $40,000 and commercial buildings $150,000.

The actual number of large contracts in the various classes of construction, together with the average cost per job, compared with January of the current

State Road Programs

Massachusetts appropriations not yet made by the Legislature. Will probably be made by middle of March and are expected to reach $9,000,000.

Rhode Island appropriations total $2,671,844.99, divided as follows: Appropriation, $300,000; motor vehicle registrations (estimated), $1,000,000; Federal Aid allotments for fiscal years 1922 and 1923 are $609,375; special state highway tax to meet Federal allotments, $600,000; unexpended balances from 1922 amount to $162,469.99.

Maryland will have available approximately $3,500,000, and $1,600,000 for maintenance.

Ohio has appropriated about $15,000,000. Awards in the first two months of this year aggregate approximately 43 miles, estimated to cost $1,300,000.

West Virginia has no specific program for 1923 as yet. About $9,000,000 worth of work carried over from 1922 will be completed and paid for this year. This amount is the balance of the $15,000,000 appropriated for road work. There has recently been appropriated $15,000,000 additional to be expended during 1923 and 1924. Of this amount, about $6,000,000 will be let to contract this year.

North Carolina plans to place under contract this year approximately 800 miles, of which 500 miles will be hard

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING FEBRUARY, 1923

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	Western	Canada	Total
Waterworks	.....	$481,000	$155,000	$743,000	$1,311,000	$40,000	.....	$2,730,000
Sewers	.....	769,000	157,000	475,000	579,000	151,000	.....	2,131,000
Bridges	$429,000	.....	332,000	370,000	1,552,000	40,000	.....	2,723,000
Excavation, drainage and irrigation	.....	25,000	.....	.....	102,000	238,000	.....	365,000
Streets and roads	647,000	294,000	3,330,000	7,897,000	4,383,000	1,972,000	$258,000	18,781,000
Industrial works	530,000	2,904,000	130,000	3,994,000	778,000	568,000	400,000	9,304,000
Buildings	1,850,000	24,506,000	5,289,000	23,349,000	11,342,000	10,866,000	615,000	77 8 .7,000
Federal Government	.....	895,000	588,000	293,000	171,000	2,126,000	.....	4,073,000
Miscellaneous	90,000	2,559,000	1,500,000	238,000	1,232,000	95,000	104,000	5,818,000
Total	$3,546,000	$32,433,000	$11,481,000	$37,359,000	$21,450,000	$16,096,000	$1,377,000	$123,742,000

surface construction, and the remaining 300 miles sand clay, top soil, gravel and macadam. The next letting will probably be in the latter part of March. The stringent material situation existing last fall has been relieved by the establishment of several large stone quarries.

Vermont—Legislature has not yet made appropriations.

Maine—Program not yet approved by the Governor and Council.

New Jersey—Program not available until approved by the State Highway Commission, which has been appointed by the Governor but not yet confirmed by the Senate.

New York—Program will be completed in a few days.

Labor Rates and Conditions Throughout the Country

Industrial conditions have shown continued improvement since the first of the year. Cotton manufacturing has developed greater activity recently than at any time in the history of the industry. Copper also occupies a stronger position than at any time during the last two years. The output of automobiles and trucks has established a new high record. Steel mill operations are at maximum capacity considering the limited labor supply and inadequate transportation facilities.

Latest Department of Labor Reports indicate an increased demand for labor in virtually every state in the union. Manufacturing industries report shortages of both skilled and unskilled operatives. Many mining districts were similarly affected, although production was held up by car shortage. Scarcity of men is reported at lumber mills as well as in the woods. Agricultural and food industries and some of the seasonal vocations, however, show labor surpluses of a purely temporary nature. New England textile mills are running overtime with shortage of skilled help. The building industry was shown to be unusually active throughout the country, considering weather conditions in certain northern sections. Labor shortage, particularly of bricklayers and plasterers, threatens seriously to handicap spring construction projects soon to be under way.

The common labor rate for the nation as applied to pick and shovel men in construction operations, is placed at 49c. per hr. as against 48c. for the preceding month, according to *Engineering News-Record's* figures. Local building conditions are as follows:

Baltimore—Scarcity of bricklayers and hodcarriers, normal supply of other trades. Carpenters strike in progress. Union carpenters' rate 90c.; non-union men receive 80c. per hr.

Birmingham—Growing scarcity of common labor, skilled men apparently plentiful.

Boston—Building activities light on account of recent cold weather but building rush expected in early spring. Just about enough hoisting engineers and hodcarriers available; scarcity of good common laborers. All other trades plentiful.

Chicago—Chicago labor rates based on Landis Award but in many cases higher rates are paid because of labor shortage. Bricklayers for past year have been receiving in many cases $1.50@$1.75 per hr. Plasterers were awarded 78½c. under Landis Award and in several instances are now receiving $10 to $15 per day.

Cincinnati—Supply of bricklayers and carpenters about normal; plenty of other crafts.

Dallas—Small surplus of bricklayers and carpenters. More than enough of most of the other trades. Excessive numbers of common laborers.

Detroit—No change in labor rates announced by Associated Building Employers. Building construction is increasing in volume and demand for men in all trades is brisk.

Kansas City—Labor plentiful in all classes.

Minneapolis—Regular rate for bricklayers $1 per hr. but men receive $1.12½ in many cases because of scarcity.

Montreal—Plenty of hodcarriers and non-union common laborers; no union for latter class. Ample supply of other building trades mechanics. Roofers, electrical workers and painters receive 65c.; plasterers 80c. per hr.

New Orleans—Labor plentiful; no complaint of shortage.

New York—Shortage of bricklayers and plasters may prove handicap to big construction program about to open up in early spring. Manhattan builders fear that plasterers, who are receiving $10 with bonuses of $2 and $4 per day, may demand $16 to $20 per day as is the case at the present time in Brooklyn. Contractors have practised taking men from each other by offering $2 to $5 per day higher than the amount received.

Philadelphia—Scarcity of bricklayers, hodcarriers and common laborers. Shortage of carpenters easing slightly because of recent freezing weather. Fair supply of structural iron workers; plenty of hoisting engineers and pile drivers.

Pittsburgh—Enough building trades mechanics but scarcity of steel-mill workers.

St. Louis—Shortage of bricklayers, being paid $1.37½ per hr. and up, will demand $1.50 May 1. Scarcity of carpenters; premiums being paid, will demand $1.25 per hr. effective May 1. Hoisting engineers rate of $1.12½ expires June 1; will then demand $1.25 per hr. Some carpenters being paid latter rate at present time. Hodcarriers will demand advance of 15c. per hr. to $1 effective May 1. Pile drivers will also ask increase to $1.25 from present rate of $1.12 on and after May 1. Few structural iron workers receiving less than $1.25 per hr., will make scale $1.25 effective Mar. 1. Union common laborers to ask rate of 67½c. per hr. as against 57½c. effective Mar. 1.

San Francisco—Weather conditions good; all construction active.

(Higher rates indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	$0.70	$0.30	.....	$0.65	$0.30@.35
Baltimore	1.25	.80@.90	.80@1.00	.87½	$0.65	.80@1.00	.30@.45
Birmingham	1.00	.75	.50@1.00	.15@.25	.....	1.00	.20@.25
Boston	1.25	1.00	90@1.00	+.80	1.00	1.00	+.60
Cincinnati	1.25	+1.00	+1.00	..+.77½	1.00	+1.00	+.40@.60
Chicago	1.10	1.00	1.10	.....	1.10	1.05	.72½
Cleveland	1.25	1.10	1.10	.75	.91	1.10	.75
Dallas	1.37½	1.00	1.00	.40	.87½	1.00	.30@.50
Denver	1.25	1.00	1.00	.75@.81½	1.00	1.03¾	.35@.50
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	+1.17½	1.00	1.00@1.25	.80	1.00	1.00	+.40@.50
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.56¼@.62½
Minneapolis	1.00	.80	.80	.65	.....	.80	.35@.50
Montreal	.90	.65	.50	—.30	.50	+.65	.25
New Orleans	1.00	.85	.90	.65	.80	1.00	.35@.40
New York	1.25	1.12½	1.25	.87½	1.00	1.12½	.45@.60
Pittsburgh	1.30	1.12½	1.00	.90	1.00	1.00	.50
St. Louis	1.25	1.10	1.12½	.85	1.12	1.12½	.40@.50
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.56¼
Seattle	1.12½	.87½	.87½@1.00	93¾	1.00	.90@1.00	.50@.65
Philadelphia	1.25@1.37½	.90@1.00	.90@ 1.00	.75@1.00	1.00	.90@1.10	.40@.65

Freight Loadings High for This Time of Year

Although freight loadings show seasonal decline due to severe weather conditions, car movements still maintain record totals for this season of the year. During the week ending Feb. 10, 853,289 cars were loaded with revenue freight according to the American Railway Association. This shows a falling off of more than 12,000 cars from the week of Feb. 3. An increase, however, is shown in comparison with the corresponding week last year.

The following table shows a comparison of freight loadings for the same weeks during the last three years:

CARS LOADED DURING SIMILAR WEEKS SINCE 1921

Week Ending	1923	1922	1921
Feb. 10	853,289	777,791	687,867
Feb. 3	865,675	747,895	699,718
Jan. 27	871,164	740,386	701,605
Jan. 20	865,578	731,109	704,658
Jan. 13	873,251	714,191	715,855
Jan. 6	770,303	599,433	697,641

Lumber loadings totaled over 64,000 cars, a drop of about 5,000 from the week preceding, but heavier by 12,000 cars than the same week in 1922.

It is noteworthy that since January, 1923, not fewer than 853,000 cars have been loaded each week; whereas at no time during the years 1921 and 1922 did loadings exceed 777,000 cars in one week. Complaints of car shortages are still heard, particularly from building materials manufacturers and dealers.

Business Briefs

Public contracts in February in the United States amounted to 42 per cent of the total, as follows: first two weeks averaged $13,745,000; third week, $13,906,000; fourth week, $9,410,000. Commercial buildings and industrial works totaled $88,000,000; streets and roads, $18,523,000.

Summing up conditions: "Were the entire financial and business history of the week to be summed up in a single phrase," says *The Annalist*, "it might be said that conditions in the United States, unfettered by the difficulties surrounding them in many countries of Europe, have improved materially. The wheels are turning faster than at this time, say, a month ago and the developments on each week are more or less the addition of new business, the resumption of long idle plants here and there, backed by the inflow of orders for goods and services, which as yet show no signs of diminution."

Money rates have stiffened from 4 per cent to 4½, which is the first advance since the successive declines which lowered the rate from 7 per cent in June, 1920, to 4 per cent in June, 1922.

Sterling advanced to within 14c. of par, a gain of 8c. since the end of January. The principal factor was Great Britain's acceptance of United States terms for the payment of her wartime debt obligations, and the tentative confirmation by Congress.

Contract Prices on Some Large February Contracts

Bridge lumber — 420 pieces bridge lumber, 3x12s, totaling 30,240 ft. b.m., $82.50 per M ft., Minneapolis, Minn.

Crushed stone—3,000 tons at $2.40, Dallas; 6,000 cu.yd. crushed traprock at $4.94, New York; 1,000 tons limestone dust at $5.80, New York.

Cement—Minneapolis bought 120,000 bbl. from four local dealers for $2.52 per bbl., net, f.o.b. cars.

Monthly Prices of Construction Materials

Ups and Downs of the Market

GENERAL upward tendency in basic building materials due to large quantity buying. Pig iron gains strength; steel at minimum of $2.25 per 100 lb., f.o.b. mill as against $2.10 last month; cement undergoing unprecedented demand, prices higher in Mid-West; lumber up $2 in New York, $3 in San Francisco and $4 per M ft. in Chicago, mills shipping as fast as materials can be turned out; steel pipe up; tendency higher in sand, gravel and crushed stone; all paint materials advanced; brick steady in North but rising in South due to labor demands in plants now operating.

Pig Iron—Market gaining strength. Coke price tending downward, but advances in finished steel, due to heavy demand, affecting pig iron prices upward. No. 2 foundry iron up 50c. in Pittsburgh; $1 per ton in Birmingham, Cincinnati and Chicago, during month.

Railway Supplies—Light rails higher at Pittsburgh mills, but maximum on rerolled $2 per ton lower. Standard spikes at minimum of $2.90 as against $2.75 and track bolts $3.85 as compared with $3.75 per 100 lb., f.o.b. Pittsburgh one month ago. Railway ties steadily advancing in Canada, empty cell creosote fir ties up 10c. in San Francisco.

Pipe—Wrought iron pipe discounts on Pittsburgh basing card down four points on black and six on galvanized since last month. Recent reduction in wrought-steel pipe discounts at Pittsburgh reflected in similar lowering in New York warehouse discounts. Following rise in pig iron, cast-iron pipe advanced $1 per ton in San Francisco, St. Louis and Chicago during month. Clay drain tile higher in Dallas; sewer pipe advanced in Pittsburgh, New York, Boston, Cincinnati, Baltimore and Kansas City.

Road and Paving Materials—Seasonal dullness still pervades road oil and asphalt markets. Despite several recent advances in crude oil, asphalt, both bulk and package, declined $3.10 per ton in Minneapolis. Bulk dropped 50c. and package $1.50 per ton in Kansas City. Boston, however, quotes rise of 50c. per ton in both bulk and package asphalt. Granite paving blocks up 15c. per sq.yd. in Boston and $5 per M in Philadelphia. Wood blocks higher in New York, New Orleans, Philadelphia and St. Louis due to lumber advances.

Sand, Gravel and Crushed Stone—Freezing weather and impeded shipments keeping prices up. St. Louis advanced sand and 1½ in. gravel 5c.; Cincinnati, 10c. per cu.yd.; Philadelphia quotes rise of 5c. per cu.yd. in gravel. Both Kansas City and Baltimore, however, report declines. Crushed stone ¾ in., up 5c. in Philadelphia, 20c. in Dallas and 25c. per cu.yd. in Cincinnati; down in Kansas City.

Lime—Hydrated finishing down 40c. per ton in St. Louis, heavier reduction in Kansas City; $1 higher in Cincinnati and up $3 per ton in Boston. Hydrated common down 20c. in St. Louis, sharp decline in Kansas City; up $1 per ton in Boston. Lump finishing declined in Kansas City, rose 50c. per bbl. in Boston and $1 in St. Louis. Common lump lime declined in Kansas City and Minneapolis, rose 12c. in Boston and $1 per bbl. in St. Louis.

Cement—Following mill rise of 10c.@15c. per bbl., adances of 10c. reported, f.o.b. Pittsburgh, Cleveland, Duluth, Minneapolis, Baltimore, Kansas City and St. Paul; 15c. in Chicago, Indianapolis, Toledo, Milwaukee, Peoria, Cedar Rapids, Davenport and Cincinnati; 14c. in Detroit and 25c. per bbl. in Atlanta during month. Unprecedented demand for cement. Western advances expected to be followed by higher prices in the East.

Structural Steel—Demand heaviest since 1920. Plates quoted at $2.20@$2.40 per 100 lb. in large tonnages; small, carlot sales at premium prices, as high as $2.50. Structurals at ruling minimum of $2.25; bars, $2.20@$2.25. Mills heavily booked, but handicapped by car and labor shortage in satisfying demands of consumers. Car materials, oil-tank plates and structurals for spring building season, form bulk of demand.

Brick and Hollow Tile—Common brick rose 50c. in Detroit; $1.15 in Dallas; $1.20 in Baltimore, and $2 per M in Atlanta since February 1. Declines of $1 per M reported in Philadelphia and St. Louis.

Lumber—Market active with all items in good demand. Heaviest mill bookings since 1916. Heavy production rate but shortage of cars. Structural timbers (yellow pine) up $2 per M ft. in New York; Douglas fir advanced $3 in San Francisco. Pine boards, dimension lumber and timbers up $1 in Minneapolis and Philadelphia; $1.50 in St. Louis; $2 in Atlanta; $4 in Kansas City and $5 per M. ft. in Denver since February 1. Hemlock and spruce also reported higher.

Scrap—Market very strong due to demand for finished steel; higher in New York and St. Louis. Quoted prices merely nominal.

Explosives—Few price changes during month; St. Louis about ½c. per lb. higher on 40@60 per cent gelatin dynamite.

Linseed Oil—Stiffening prices reflect general upward tendency in nearly all paint materials. Raw oil up 8c. in New York and 9c. per gal. in Chicago since last month. Higher prices in Dallas, Minneapolis, Denver and San Francisco.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Mar. 1	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	**$29.05**	$20.50
Northern Basic	**29.77**	21.02
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	**30.27**	22.52
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	33.44	26.26
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	**25.00**	16.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	**30.14**	21.76
Virginia No. 2 (silicon 2.25 @ 2.75)	33.17	27.74
Basic	**28.50**	19.84
Gray Forge	**29.00**	21.50
CHICAGO		
No. 2 Foundry Local (silicon 1.75@ 2.25)	**30.00**	20.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	**31.01**	22.67
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	**28.50**	21.96
Basic	*28.50*	19.96
Bessemer	29.27	21.46

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Mar. 1	Pittsburgh One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$40.00	.....	$43.00	43.00
Standard openhearth rails	43.00	40.00	$43.00	43.00	43.00
Light rails, 8 to 10 lb.	43@45	28@30	2.00*	43.00	43.00
Light rails, 12 to 14 lb.	43@45	28@30	2.00*	43.00	43.00
Light rails, 25 to 45 lb.	43@45	28@30	2.00*	43.00	43.00
Rerolled Rails	28@30	1.45@1.50*	.....	.....	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.50	$1.65
Chicago, Hardwood and Red Oak	1.25	1.40
Chicago....Empty Cell Creosoting (add'l)	.45	.50
San Francisco..... Green Douglas Fir	.84	*1.14*
San Francisco, Empty Cell Creosoted, Douglas Fir	**1.70**	2.25
St. Louis, White Oak	1.30	1.55
St. Louis (creosoted) (zinc treated)	1.70	2.05
St. Louis, Red Oak, plain	1.15	1.40
St. Louis, Sap pine-cypress	1.05	1.30

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Mar. 1	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	**$2.90**	$2.20@2.25	$3.00	$3.60	$4.45	$3.29
Track bolts	**3.85@4.50**	3.25	4.00	4.70	5.45	4.29
Standard section angle bars	2.75	2.40	2.75	3.45	4.10	2.94

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
¼ to 3	**64**	**52½**	⅜ to 1½	**30**	**13**
1 to 3	**62**	**51½**	⅜ to 1½	**30**	**14**
2 to 3	**63**	**52½**			

LAP WELD

2	**57**	**45½**	2	**23**	**7**
2½ to 6	**61**	**49½**	2½ to 4	**26**	**11**
7 to 8	**58**	**45½**	4½ to 6	**28**	**13**
9 to 12	**57**	**44½**	7 to 12	**26**	**11**
1 to 1½	**62**	**51½**	1 to 1½	**30**	**14**
2 to 3	**63**	**52½**			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	**55**	**44½**	2	**23**	**9**
2½ to 4	**59**	**48½**	2½ to 4	**29**	**15**
4½ to 6	**58**	**47½**	4½ to 6	**28**	**14**
7 to 8	**54**	**41½**	7 to 8	**21**	**7**
9 to 12	**48**	**35½**	9 to 12	**16**	**2**

STEEL PIPE—From warehouses at the places named the following discounts hold, for steel pipe:

	Black New York	Black Chicago	Black St. Louis
1 to 3 in. butt welded	**58%**	62½%	**57%**
2½ to 6 in. lap welded	**51%**	59½%	**54%**

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
1 to 3 in. butt welded	**41%**	48½%	**44%**
2½ to 6 in. lap welded	**38%**	45½%	**41%**

Malleable fittings, Classes B and C, banded, from New York stock **sell at list less 1%**. Cast iron, standard sizes, **25%** off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	New York Mar. 1	New York One Year Ago	Chicago	St. Louis	San Francisco
4 in.	**$49.00**	*$61.00*	$50.50	**$58.20**	$54.60	**$61.00**
6 in. and over	**45.00**	*56.50*	47.30@48.30	**54.20**	50.60	**57.00**

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin. ft.:

Size, In.	New York Mar. 1	New York One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$40.00	$40.00	$62.50	.....	**$73.00**
4	55.00	50.00	40.00	75.00	$76.50	**83.00**
5	80.00	80.00	75.00	100.00	97.75	**108.00**
6	105.00	100.00	75.00	175.00	127.50	**133.00**
8	170.00	150.00	170.00	187.50	212.50	**199.00**

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	**$0.15**	**$0.108**	.....	.....	**$0.15**	**$0.12**	.....
4	**15**	**108**	$0.10	$0.0875	.15	.15	$0.12
5	**21**	**162**	.125	.....	.23	.18	.16
6	**21**	**162**	.150	.1225	.23	.21	.1855
8	**35**	**252**	.225	.20	.35	**.30**	.30
10	**515**	**378**	.2925	.28	.53	**.42**	.44‡
12	**656**	**486**	.3825	.36	.68	.54	.567
15	**1.07†**	**648**	.5625	.60†	.90	**.90**	.819
18	**1.56†**	**.90**	.765	.84†	1.25	**1.32**	1.071
20	**1.87†**	**1.08**	1.0125	1.12†	1.50	.....	.....
22	**2.496†**	**1.44**	1.2375	.....	2.00	.....	1.44‡
24	**2.808†**	**1.62**	1.4625	1.44†	2.25	**2.16**	1.89
27	**4.68†**	**2.86**	.....	2.45†	4.69†	**3.00**	3.34
30	**5.20†**	**3.168**	.....	3.00†	5.94†	**3.60**	4.06
33	**6.76†**	**4.23**	.....	3.55†	6.88†	.....	4.99
36	**7.80†**	**4.8175**	.....	3.95†	7.50†	.....	5.42

	3	5	8	12	24	36
Boston	**$0.125**	**$0.19**	**$0.30**	**$0.578**	**$1.90†**	**$5.75†**
Minneapolis	.....	.....	.40	.72	2.55	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	*.15*	.....	.36	.72†	2.60†	.....
Los Angeles	.....	.....	.....	.....	.....	.....
New Orleans	.112*	.168*	.28	.476	1.18†	.....
Cincinnati	**.14**	**.215**	**.34**	**.66**	**2.25**	4.92†
Atlanta	.108*	.162*	.27	.459	1.75‡	.....
Montreal, *delivered*	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	.102	.153	.238	.459	1.98†	6.15†
Baltimore	**.12**	**.18**	**.28**	**.54**	**1.80**	**5.2275**
Kansas City, Mo	.135*	.19*	**.54***	**.90**	2.16	.....
Philadelphia	.12	.18	.28	.54	1.80†	*4.00†*

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Mar. 1	One Year Ago
New York, 45% asphalt	(at terminal)	$0.06	$0.05
New York, 65% asphalt	(at terminal)	.06	.046
New York, binder	(at terminal)	.06½	.06
New York, flux	(at terminal)	.06½	.05½
New York, liquid asphalt	(at terminal)	.07	.06
St. Louis, 50@60% asphalt		.0548	.03½
St. Louis, 60@70% asphalt		.0565	.....
Chicago, 40–50% asphalt		.05½	.05
Chicago, 60–70% asphalt		.05½	.05½
Dallas, 45% asphalt		04	.10
Dallas, 55% asphalt		048	.13
Dallas, binder		053	.15
San Francisco, binder, per ton		9.50*	13.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$20.00	$16.00
Boston (*Mexican*)	20.00	16.50
Chicago (*Standolind*)	22.25	16.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00*	11.00*
Dallas, (*Texas*)	23.00	15.00
Seattle, "*D*" *grade* (*California*)	21.25	11.00†
Denver (*California*)	40.00	....
Minneapolis *f.o.b. Twin Cities* (*Standolind*)	*22.35*	*16.00*
St. Louis (*Mexican*)	27.50	19.75
Baltimore (*Standard Oil*)	21.00	15.00
Los Angeles, *at factory, Bakersfield* (*California*)	....	....
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	22.00	16.50
Detroit (*Mexican*)	23.65	18.95
Cincinnati (*Kentucky Rock*)	22.50	19.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	18.00	15.50
Philadelphia (*Mexican*)	20.00	16.00
Kansas City (*Texas*)	*27.30*	*22.30*

*Freight to San Francisco, 80c. per ton.

†F.o.b. Richmond, Cal.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York	5-in. granite, 30 blocks per sq.yd.	$4.45 per sq.yd.
Chicago	About 4x8x4 dressed	3.60 per sq.yd.
	About 4x8x4 common	3.15 per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M
Boston	5-in. granite	2.25 per sq.yd.
Atlanta	Granite	2.10 per sq.yd.
Detroit	5-in Granite	3.00 per sq.yd.
	4-in Granite	3.25 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	100.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	4x8x4 dressed	3.10 per sq.yd.
	4x8x4 common	2.90 per sq.yd.
Kansas City	Granite	3.75 per sq.yd.
Philadelphia	Granite	135.00 per M.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per square
	Manhattan, 4 ft. wide	.22 per square
	Queens, 5 ft. wide	.24 per square
	6x24-in. cross-walk	1.00 lin.ft.
Chicago	18 in. wide	.99 lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 75c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., $1.40 per lin.ft. *Chicago*: 5 x 18 in., delivered, $3 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.47
New York (*delivered*)	3½	16	3.04
Boston	3½	16	2.35
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50
St. Louis	3½	16	2.75
St. Louis	4	16	3.10
Seattle	4	16	Off market
Minneapolis	3½	16	2.09
Atlanta	3½	16	2.30
New Orleans	3	16	2.10
New Orleans	3½	16	2.30
New Orleans	4	16	2.60
Dallas	4	18	3.90
Baltimore	3½	16	none used
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.38
Kansas City	4	16	2.65
Philadelphia	3½	16	2.50

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Mar. 1	Gravel 1½ In. One Year Ago	Gravel ¾ In. Mar. 1	Gravel ¾ In. One Year Ago	Sand Mar. 1	Sand One Year Ago
New York	$2.00	$1.75	$2.00	$1.75	$1.00	$1.00
Denver	1.90	2.50	1.90	2.50	1.00	1.10
Chicago	2.25	2.00	2.25	2.00	2.25	2.00
St. Louis	1.45†	1.25†	1.65†	1.30†	1.45†	1.20†
Seattle	1.00	1.50	1.00	1.50	1.00	1.50
Dallas	2.25	2.00	2.25	2.00	1.87½	2.00
Minneapolis	1.75*	1.50	1.75*	1.50	1.00	1.00*
Cincinnati	1.50†	2.00	1.50†	2.00	1.25†	1.69
San Francisco	2.15	2.25	2.15	2.25	1.50	1.50
Boston	1.40†	2.40	1.40†	2.40	1.10†	1.65
New Orleans	2.85	2.08½	2.85	2.08½	1.35	1.35
Los Angeles	....	1.50†	....	1.50†	....	1.35†
Atlanta	1.75†	1.85†	1.75†	1.85†	1.24†	1.15†
Detroit	2.25	2.00	2.25	2.00	2.00	2.00
Baltimore	1.86	1.40	*2.06*	1.60	0.70†	2.00
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					1.25†	1.25†
Philadelphia	1.75	1.50	1.80	1.55	1.70	1.60
Kansas City	*1.60*†	2.00	*1.60*†	2.00	0.66*	1.20

New York—Grit, $1.75 per cu. yd.

Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.

* At pit.

† Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Mar. 1	1½ In. One Year Ago	¾ In. Mar. 1	¾ In. One Year Ago
New York	$1.65	$1.75@1.85	$1.75	$1.75@1.85
Chicago	2.25	1.60	2.25	1.60
St. Louis *delivered*	2.00	1.65	2.10	1.65
Dallas	2.00	2.93	2.00	2.93
San Francisco	2.15	2.25	2.15	2.25
Boston, *delivered*	1.85*	3.00*	1.85*	3.00*
Minneapolis, *at plant*	2.00	2.00	2.25	2.25
Kansas City	*1.50*	2.10	*1.50*	2.10
Denver	3.50	3.50	3.50	3.50
Seattle *delivered*	3.00	3.00	3.00	3.00
Atlanta	2.00*	1.90*	2.00*	1.90*
Cincinnati	1.75*	2.37½	2.25*	2.08
Los Angeles	....	1.75*	....	1.85*
Detroit	1.90@2*	1.90*	1.90@2*	1.90*
Baltimore	2.37	1.75*	2.43	1.65*
Montreal	1.80*	2.00*	1.90*	2.10*
Birmingham *delivered*	3.20	3.20	3.10	3.10
Phildelphia	1.80*	1.70*	1.65*	1.55*
Pittsburgh	2.85	....	2.85	....
Cleveland	3.00*	....	3.00*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
East Canaan, Conn.	1.25	1.35	4.00	1.00
Easton, Catasaqua, Pa.	1.00	1.00	2.00	0.90
Birmingham, Ala.	1.00	1.00	1.00	1.00
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.00	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$16.80@$17.10	$13.10	$3.75*	$3.00@$3.25*
Chicago	20.00	20.00	1.50†	1.50†
St. Louis	*22.00*	*19.00*	18.75‡	18.75‡
Boston	21.00	14.50	4.40*	3.12*
Dallas	22.50	....	....	2.50†
Cincinnati	16.80	13.30	....	10.75‡
San Francisco	22.00	16.00	....	1.75†
Minneapolis	25.50	21.00 (white)	1.55†	*1.25*†
Denver	24.00	....	....	2.70†
Detroit	19.50	17.50	....	18.25‡
Seattle *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	....	....	....	.....
Baltimore	22.00	16.25	....	.....
Montreal	21.00	21.00	15.00‡	11.00‡
Atlanta	23.00	20.00	2.25†	1.85†
New Orleans	....	17.25	2.40†	
Philadelphia	15.50	14.50	13.00‡	12.00‡
Kansas City	*20.00*	*16.00*	*13.00*‡	*13.00*‡

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.55, Sheboygan $1.45. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Mar. 1	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.50	1.60
Atlanta (Magnolia)	11.00 per ton	11.00 per ton
Cincinnati (Utica)	1.72	1.93
Boston (Rosendale)	2.60	0.85 per bag
St. Louis (Carney)	1.75	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Mar. 1	One Month Ago	One Year Ago
New York, del. by truck	$2.60@2.70	$2.60@2.70	$2.30
New York, alongside dock to dealers	2.30	2.30	2.00
Jersey City	2.48	2.48	2.12
Boston	2.75	2.75	2.50
Chicago	2.20	2.05	1.94
Pittsburgh	2.24	2.14	2.02
Cleveland	2.46	2.36	2.26
Detroit	2.47	2.33	2.17
Indianapolis	2.41	2.26	2.21
Toledo	2.48	2.33	2.20
Milwaukee	2.37	2.22	2.13
Duluth	2.14	2.04	1.95
Peoria	2.41	2.26	1.98
Cedar Rapids	2.48	2.33	2.11
Davenport	2.43	2.28	2.06
St. Louis	2.35	2.35	2.20
San Francisco	2.71	2.71	2.73
New Orleans	3.30	3.30	3.20
Minneapolis	2.39	2.29	2.24
Denver	2.85	2.85	2.90
Seattle	2.90	2.90	2.94
Dallas	2.25	2.25	2.40
Atlanta	2.75	2.50	2.39
Cincinnati	2.54	2.39	2.32
Los Angeles	....	....	3.30
Baltimore	2.61	2.51	2.50
Birmingham	2.40	2.40	2.27
Kansas City	2.45	2.35	2.40
Montreal (*delivered*)	2.88	2.15	2.40
Philadelphia	2.41	2.41	2.21
St. Paul	2.39	2.29	2.24

NOTE—Bags 10c. each, 40c. per bbl.;

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.95	La Salle, Ill.	$2.05
Universal, Pa.	2.00	Hudson, N. Y.	2.20
Steelton, Minn.	1.95	Leeds, Ala.	2.20
Fordwick, Va.	2.20	Hannibal, Mo.	2.10
Mitchell, Ind.	2.05	Lehigh Valley District	2.10
Iola, Kan.	2.10	Wyandotte, Mich.	2.05
Mason City, Ia.	2.05	Alpena, Mich.	1.85

TRIANGLE MESH—Price per 100 sq.ft in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
032	22	$0 89	$1 17	$0 96	$0 98	*$1 09*	$1 03
049	28	1 13	1 49	1 23	1 25	*1 39*	1 34
068	35	1 38	1 83	1 50	1 53	*1 61*	1 68
093	45	1 78	2 35	1 93	1 97	*1 935*	2 10
126	57	2 19	2 85	2 38	2 44	*2 451*	2 60
153	68	2 62	3 39	2 85	2 91	*3 05*	....
180	78	3 00	3 85	3 27	3 34	*3 331*	....
245	103	3 97	5 25	4 32	4 41	*4 427*	....
287	1.9	4 58	6 14	4 98	5 09	*5.115*	5 43
336	138	5 31	7.05	5 78	5 90	*5.934*	....
395	160	6.16	8.13	6 70	6.85	*6.88*	....

PAVING

036P	17	$0.68	$0 88	$0.74	$0 75	*$0.731*	....
053P	24	.96	1 19	1 04	1.06	*1.032*	....
072P	31	1.21	1 58	1 32	1 34	*1 333*	....
097P	40	1.56	2.08	1 70	1.73	*1 84*	....
049R	24	.96	....	1.04	1.06	*1.032*	....
067R	31	1.21	....	1.32	1 34	*1.333*	....
089R	40	1.56	....	1.70	1.73	*1.84*	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27Dia.	2.3	$22 00	$20 39	$20 72	*$20 00*	$25 50
26 "	2.5	22 00	21 93	22 39	*20 75*	27 58
25 "	3.0	22 00	24 45	24 93	....	30 71
24 "	3.4	24 00	26 33	27 10	*23 50*	33 16
22 "	4.33	27 00	31 06	32 27	....	35 10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.00	$2 35	$3 19	$3 07½	$2 90	$3 15	$3 30
⅝	2.05	2 45	3 24	3 12½	2 95	3 20	3 35
¾	2.10	2.55	3 29	3 17½	3 00	3 25	3 40
⅞	2.25	2.60	3 34	3 32½	3 15	3 40	3 55
1	2.50	2.65	3.69	3 57½	3 30	3.65	3.80

Includes 15c charge for cutting to lengths of 2 ft. and over. Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2 10	$2.60	$2.85	½	$2 35	$2.85	$3 10
⅝ in	2 15	2.65	2.90	⅝	2.60	3.00	3 35
¾	2 20	2.70	2.95	¾	....	....	....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Mar. 1	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$23.50	$23.50	$21.40	$42.00†	$50.00†
New York (at dock)	20.00	20.00	18.00	....	....
Chicago	11 00	11 00	11 00	34 00	42 00
St. Louis, salmon	*15.00*	16.00	17 00	36 50	*40.00*
Denver, salmon	12 00	12.00	14 00	....	....
Dallas	11 00	9.85	11 00	33.00	....
San Francisco	15 50	15.50	15 50	....	....
Los Angeles (del.)	....	....	15 00	(not used)	
Boston	20 00	20.00	16.00	72.00	72 00
Minneapolis (del.)	17@19	17@19	15.00	....	43.00
Kansas City	14 50	14.50	14 50	....	....
Seattle	13 00	13 00	14 00	50 00	....
Cincinnati	18 00	18.00	17.00	43 00	43 00
Montreal	16 00	16 00	16 00	100.00‡	68 00
Detroit (del.)	16.50@17 50	16.50@17	16.50	38 50	41.50
Baltimore (del.)	19.20	18.00	20.00	40.00	45.00
Atlanta	12 00	10 00	8.25	39.00	....
New Orleans	15 75	15 75	12.50	....	....
Birmingham	12 50	12 50	10.50	....	....
Philadelphia	*19@25*	20@28	16.00	40.00	48.00
Pittsburgh (del.)	16.00	16.00	....	....	....
Cleveland	16.00	16.00	....	....	....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Mar. 1 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0 123	$0.1112	$0.0674	$0.12	$0.088	$0.108	....
6x12x12	.1844	.1667	.0926	....	.11	.156	....
8x12x12	.2305	.2084	.1263	.1875	.15	.244	$0.2147
10x12x12	....	....	.1621	....	.18	....	.2653
12x12x12	....	....	.1853	....	.22	....	.3448

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.11	$0.21	....
Minneapolis (f.o.b. cars)	.736	.12125	$0.214
Minneapolis (delivered)	.0836	.1369	.239
Cincinnati	.0859	.1611	....
Kansas City	.083	.145	....
Denver	.065	.123	.188
Seattle (delivered)	.11	.25	.36
Los Angeles factory	....	....	....
New Orleans	.12	.23	.36
Detroit (delivered)	.09	.175	.26
Montreal	.115	.225	.30
Baltimore	.10	.215	....
Atlanta	.0859	.1615	....
Dallas	.115	....	....
Birmingham	.11	.18	....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.08	.164	....

San Francisco, Philadelphia, Atlanta, New York and Chicago quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburg and Birmingham together with quotations per 100 lb. from warehouses at place named.

	Pittsburgh, Mill	Birmingham Mill	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2 15@2.25	$2 40	3.29	$4 40	$3.00	$3 05	$3 35
Channel, 3 to 15 in.	2 15@2.25	2 40	3 29	4 40	3.00	3 05	3 35
Angles, 3 to 6 in., ¼ in. thick	2 15@2 25	2 40	3 29	4 40	3 00	3 05	3 35
Tees, 3 in. and larger	2 15@2.25	2 40	3 29	4 40	3 00	3 05	3 35
Plates, ¼ in. thick and ⅛ heavier	2.15@2.25	2 40	3 29	4 40	3.00	3.05	3 45

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York, Mar. 1	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.00	$3 85	$3.50	$3.75	$3 85	$4.75	*$4.95*

CONE HEAD BOILER

½ in. and larger	$3.10	3.95	3.60	3.85	3.95	4.85	*5.05*
⅝ and ¾	3.25	4.11	3.76	4.00	4.10	5.00	*5.20*
⅞ and 1	3.50	4.35	4 00	4.25	4.35	5 25	*5.45*

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.80@3.00	$3.45	$4.10	*$4.25*	*$3.14*	$4.95
Cut	3.20@3.25	5.50	5.80	*5.75*	*3.24*	5.00

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.16 per roll in carload lots and $2.70 for smaller quantities f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $5.50 per square (sufficient to cover 100 sq.ft.) in carloads; $5.75 in smaller quantities, f.o.b. Philadelphia Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., $6.05.

ROOFING MATERIALS—Prices f.o.b. New York, in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$73.50
Tar pitch (in 400-lb. bbl.), per 100 lb.	1.62½
Asphalt roofing (in barrels), per ton, f.o.b. plant*	37.00
Asphalt felt (light), per ton, f.o.b. plant*	67.50
Asphalt felt (heavy), per ton, f.o.b. plant*	67.50

* Delivered in Metropolitan Dist., $3.00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2 50@2.75	4.10	$4.00	$4.35	$4.19
No. 12	2.60@2.85	4.15	4.05	4 40	4 24
No. 14	2 70@2.95	4.20	4 10	4 45	4.29
No. 16	2 90@3.15	4.30	4.20	4 55	4 39
Black					
*Nos. 18 and 20	3 20@3.35	4.65	4.70	5 70	4.70
*Nos. 22 and 24	3 25@3.40	4 70	4 70	5 75	4.75
*No. 26	3 30@3.45	4.75	4 75	5 80	4.80
*No. 28	3 35@3.50	4.80	4 85	5 90	4.90
Galvanized					
No. 10	3.35@3.75	4.85	4 85	....	4.90
No. 12	3 45@3.85	4.95	4 95	5.85	5.00
No. 14	3 45@3.85	5.00	4 95	5.85	5.00
Nos. 17 to 21	3 75@4.15	5.10	....	6.15	5.30
Nos. 22 and 24	3 90@4.30	5.40	5 40	6.30	5.45
*Nos. 25 and 26	4 05@4.45	5.55	5 55	6.45	5.60
*No. 28	4.35@4.75	5.85	5.90	6.75	5.90

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages: for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Mar. 1	New York: One Year Ago	Chicago: Mar. 1	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$1.01	$0.87	$1 07	$0.91

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$20 00	$16.00
Boston (*Mexican*)	20 00	16 50
Chicago (*Stanolind*)	22 25	16 00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00*	11.00*
Dallas, (*Texas*)	23 00	15.00
Seattle, "*D*" *grade* (*California*)	21 25	11.00†
Denver (*California*)	40 00	
Minneapolis *f.o.b. Twin Cities* (*Stanolind*)	*22.35*	*16.00*
St. Louis (*Mexican*)	27 50	19 75
Baltimore (*Standard Oil*)	21.00	15.00
Los Angeles, *at factory*, *Bakersfield* (*California*)		
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	22 00	16 50
Detroit (*Mexican*)	23 6n	18 95
Cincinnati (*Kentucky Rock*)	22.50	19.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	18.00	15.50
Philadelphia (*Mexican*)	20.00	16.00
Kansas City (*Texas*)	*27.30*	*22.30*

*Freight to San Francisco, 80c. per ton.

†F.o.b. Richmond, Cal.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York	5-in. granite, 30 blocks per sq.yd.	$4.45 per sq.yd.
Chicago	About 4x8x4 dressed	3.60 per sq.yd.
	About 4x8x4 common	3.15 per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M
Boston	5-in. granite	2.25 per sq.yd.
Atlanta	Granite	2.10 per sq.yd.
Detroit	5-in Granite	3.00 per sq.yd.
	4-in Granite	3.25 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	100.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	4x8x4 dressed	3.10 per sq.yd.
	4x8x4 common	2.90 per sq.yd.
Kansas City	Granite	3.75 per sq.yd.
Philadelphia	Granite	135.00 per M.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per square
	Manhattan, 4 ft. wide	.22 per square
	Queens, 5 ft. wide	.24 per square
	6x24-in. cross-walk	1.00 lin.ft.
Chicago	18 in. wide	.99 lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 75c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., $1.40 per lin.ft. *Chicago*: 5 x 18 in., delivered, $3 per lin.ft.

WOOD BLOCK PAVING—	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2 47
New York (*delivered*)	3½	16	3.04
Boston	3½	16	2.35
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50
St. Louis	3½	16	2.75
St. Louis	4	16	3.10
Seattle	4	16	Off market
Minneapolis	3½	16	2.09
Atlanta	3½	16	2.30
New Orleans	3	16	2 10
New Orleans	3½	16	2.30
New Orleans	4	16	2.60
Dallas	4	18	3.90
Baltimore	3½	16	none used
Montreal	4	16	4 50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.38
Kansas City	4	16	2.65
Philadelphia	3½	16	2.50

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Mar. 1	Gravel 1½ In. One Year Ago	Gravel ¾ In. Mar. 1	Gravel ¾ In. One Year Ago	Sand Mar. 1	Sand One Year Ago
New York	$2 00	$1.75	$2.00	$1.75	$1.00	$1.00
Denver	1.90	2.50	1.90	2.50	1.00	1.10
Chicago	2.25	2.00	2.25	2.00	2.25	2.00
St. Louis	1.45†	1.25†	1.65†	1.30†	1.45†	1.20†
Seattle	1.00	1.50	1.00	1.50	1.00	1.50
Dallas	2.25	2.00	2.25	2.00	1.87½	2.00
Minneapolis	1.75*	1.50	1.75*	1.50	1.00	1.00*
Cincinnati	1.50†	2.00	1.50†	2.00	1.25†	1.69
San Francisco	2.15	2.25	2.15	2.25	1.50	1.50
Boston	1.40†	2.40	1.40†	2.40	1.10†	1.65
New Orleans	2.85	2.08½	2.85	2.08½	1.35	1.35
Los Angeles		1.50†		1.50†		1.35†
Atlanta	1.75†	1.85†	1.75†	1.85†	1.24†	1.15†
Detroit	2.25	2.00	2.25	2.00	2.00	2.00
Baltimore	1.86	1.40	*2.06*	1.60	0.70†	2.00
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					1.25†	1.25†
Philadelphia	1.75	1.50	1.80	1.55	1.70	1.60
Kansas City	*1.60*†	2.00	*1.60*†	2.00	0.66*	1.20

New York—Grit, $1.75 per cu. yd.

Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.

* At pit.

† Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Mar. 1	1½ In. One Year Ago	¾ In. Mar. 1	¾ In. One Year Ago
New York	$1.65	$1.75@1.85	$1.75	$1.75@1.85
Chicago	2.25	1.60	2.25	1.60
St. Louis *delivered*	2.00	1.65	2.10	1.65
Dallas	2 00	2.93	2.00	2.93
San Francisco	2.15	2.25	2.15	2.25
Boston, *delivered*	1.85*	3.00*	1.85*	3.00*
Minneapolis, *at plant*	2 00	2.00	2.25	2.25
Kansas City	*1.50*	2.10	*1.50*	2.10
Denver	3.50	3.50	3.50	3.50
Seattle *delivered*	3.00	3.00	3.00	3.00
Atlanta	2.00*	1.90*	2 00*	1.90*
Cincinnati	1.75*	2.37½	2.25*	2.08
Los Angeles		1.75*		1.85*
Detroit	1.90@2*	1.90*	1.90@2*	1.90*
Baltimore	2.37	1.75*	2.43	1.65*
Montreal	1.80*	2.00*	1.90*	2.10*
Birmingham *delivered*	3.20	3.20	3.10	3.10
Phildelphia	1.80*	1.70*	1.65*	1.55*
Pittsburgh	2.85	....	2.85	....
Cleveland	3.00*	....	3.00*	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.30	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
East Canaan, Conn.	1.25	1.35	4.00	1.00
Easton, Catasaqua, Pa	1.00	1.00	2.00	0.90
Birmingham, Ala	1.00	1.00	1.00	1.00
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.20	1.20	....	1.00
Eastern Pennsylvania and Northern New Jersey	1.20	1.20	2.00	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$16.80@$17.10	$13.10	$3.75*	$3.00@$3.25*
Chicago	20.00	20 00	1.50†	1.50†
St. Louis	*22.00*	*19.00*	18 75‡	18 75‡
Boston	21.00	14.50	4.40*	3.12*
Dallas	22.50	....	....	2.50†
Cincinnati	16 80	13.30	....	10.75‡
San Francisco	22.00	16.00	....	1.75†
Minneapolis	25.50	21.00 (white)	1.55†	*1.85*†
Denver	24.00	....	....	2.70†
Detroit	19.50	17.50	....	18.25‡
Seattle *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	.....	.....	....	.....
Baltimore	22.00	16.25	.....	.....
Montreal	21.00	21.00	15.00‡	11.00‡
Atlanta	23.00	20.00	2.25†	1.85†
New Orleans	.....	17.25	2.40†	.....
Philadelphia	15.50	14.50	13.00‡	12.00‡
Kansas City	*20.00*	*16.00*	*13.00*‡	*13.00*‡

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.55; Sheboygan $1.45. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Mar. 1	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.50	1.60
Atlanta (Magnolia)	11.00 per ton	11.00 per ton
Cincinnati (Utica)	1.72	1.93
Boston (Rosendale)	2.60	0.85 per bag
St. Louis (Carney)	1.75	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Mar. 1	One Month Ago	One Year Ago
New York, del. by truck	$2.60@2.70	$2.60@2.70	$2.30
New York, alongside dock to dealers	2.30	2.30	2.00
Jersey City	2.48	2.48	2 12
Boston	2.75	2.75	2.50
Chicago	2.20	2.05	1.94
Pittsburgh	2.24	2.14	2.02
Cleveland	2.46	2.36	2.26
Detroit	2.47	2.33	2.17
Indianapolis	2.41	2.26	2.21
Toledo	2.48	2.33	2.20
Milwaukee	2.37	2.22	2.13
Duluth	2.14	2.04	1.95
Peoria	2.41	2.26	1.98
Cedar Rapids	2.48	2.33	2.11
Davenport	2.43	2.28	2.06
St. Louis	2.35	2.35	2.20
San Francisco	2.71	2.71	2.73
New Orleans	3.30	3.30	3.20
Minneapolis	2.39	2.29	2.24
Denver	2.85	2.85	2.90
Seattle	2.90	2.90	2.94
Dallas	2.25	2.25	2.40
Atlanta	2.75	2.50	2.39
Cincinnati	2.54	2.39	2.32
Los Angeles	....	....	3.30
Baltimore	2.61	2.51	2.50
Birmingham	2.40	2.40	2.27
Kansas City	2.45	2.35	2.40
Montreal (*delivered*)	2.88	2.15	2.40
Philadelphia	2.41	2.41	2.21
St. Paul	2.39	2.29	2.24

NOTE—Bags 10c. each, 40c. per bbl.;

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.95	La Salle, Ill.	$2.05
Universal, Pa.	2.00	Hudson, N. Y.	2.20
Steelton, Minn.	1.95	Leeds, Ala.	2.20
Fordwick, Va.	2.20	Hannibal, Mo.	2.10
Mitchell, Ind.	2.05	Lehigh Valley District	2.10
Iola, Kan.	2.10	Wyandotte, Mich.	2.05
Mason City, Ia.	2.05	Alpena, Mich.	1.85

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh, Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
032	22	$0 89	$1 17	$0 96	$0 98	$1 09	$1 03
049	28	1 13	1 49	1 23	1 25	1 33	1 34
068	35	1 38	1 83	1 50	1 53	1 61	1 68
093	45	1 78	2 35	1 93	1 97	1 935	2 10
126	57	2 19	2 85	2 38	2 44	2 451	2 60
153	68	2 62	3 39	2 85	2 91	3 05	....
180	78	3 00	3 85	3 27	3 34	3 331	....
245	103	3 97	5 25	4 32	4 41	4 427	....
287	1 9	4 58	6 14	4 98	5 09	5 115	5 43
336	138	5 31	7.05	5 78	5 90	5 934	....
395	160	6 16	8 13	6 70	6 85	6.88	....
		PAVING					
036P	17	$0 68	$0 88	$0.74	$0 75	$0.731	....
053P	24	96	1 3	1 04	1.06	1 032	....
022P	31	1 21	1 58	1 32	1 34	1 333	....
097P	40	1 56	2 08	1 70	1 73	1 84	....
049R	24	96	....	1 04	1.06	1 032	....
067R	31	1 21	....	1 32	1 34	1 333	....
089R	40	1 56	....	1.70	1.73	1 84	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27Dia.	2.3	$22 00	$20 39	$20 72	$20 00	$25 50
26 "	2.5	22 00	21 93	22 39	20 75	27 58
25 "	3.0	22 00	24 45	24 93	....	30 71
24 "	3.4	24 00	26 33	27 10	23 50	33 16
22 "	4.33	27.00	31 06	32 27	....	35 10

* Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2 00	$2 35	$3 19	$3 07½	$2 90	$3 15	$3 30
⅝	2 05	2 45	3 24	3 12½	2 95	3 20	3 35
¾	2 10	2 55	3 29	3 17½	3 00	3 25	3 40
⅞	2 25	2 60	3 34	3 32½	3 15	3 40	3 55
1	2.50	2 65	3 69	3 57½	3 30	3.65	3.80

Includes 15c charge for cutting to lengths of 2 ft. and over. Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2 10	$2.60	$2 85	⅝	$2 35	$2 85	$3 10
¾ in.	2 15	2 65	2 90	⅞	2 60	3 00	3 35
1	2 20	2 70	2 95		....	....	....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Mar. 1	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$23.50	$23.50	$21.40	$42.00†	$50.00†
New York (at dock)	20.00	20.00	18.00	....	....
Chicago	11 00	11 00	11 00	34.00	42 00
St. Louis, salmon	15 00	16 00	17 00	36.50	40.00
Denver, salmon	12 00	12.00	14 00	....	....
Dallas	11 00	9 85	11 00	33.00	....
San Francisco	15 50	15.50	15 50	....	....
Los Angeles (del.)	....	....	15 00	(not used)	
Boston	20 00	20.00	16.00	72.00	72 00
Minneapolis (del.)	17@19	17@19	15.00	....	43.00
Kansas City	14 50	14.50	14 50	....	....
Seattle	13 00	13 00	14 00	50 00	....
Cincinnati	18 00	18.00	17.00	43 00	43.00
Montreal	16 00	16 00	16 00	100.00‡	68 00
Detroit (del.)	16.50@17 50	16.50@17	16 50	38 50	41.50
Baltimore (del.)	19.20	18 00	20.00	40.00	45.00
Atlanta	12 00	10 00	8.25	39.00	....
New Orleans	15 75	15 75	12.50	....	....
Birmingham	12 50	12 50	10.50	....	....
Philadelphia	19@25	20@28	16.00	40 00	48.00
Pittsburgh (del.)	16.00	16.00	....	....	....
Cleveland	16.00	16.00	....	....	....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Mar. 1 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0 123	$0.1112	$0.0674	$0.12	$0.088	$0.108	.....
6x12x12	.1844	.1667	.0926	.....	.11	.156	.....
8x12x12	.2305	.2084	.1263	.1875	.15	.244	$0.2147
10x12x12	.....	.....	.1621	.....	.18	.....	.2653
12x12x12	.....	.....	.1853	.....	.22	.....	.3448

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.11	$0.21	
Minneapolis (f.o.b. cars)	736	.12125	$0.214
Minneapolis (delivered)	.0836	.1369	.239
Cincinnati	.0859	.1611	....
Kansas City	.083	.145	....
Denver	.065	.123	.188
Seattle (delivered)	.11	.25	.36
Los Angeles factory	.12	.23	.36
New Orleans	.09	.175	.26
Detroit (delivered)	.115	.225	.30
Montreal	.10	.215	.....
Baltimore	.0859	.1615	.....
Atlanta	.115	.18	.....
Dallas	.11	.18	.....
Birmingham	.068	.128	.179
Pittsburgh (delivered)	.08	.164	.....
Cleveland			

San Francisco, Philadelphia, Atlanta, New York and Chicago quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburg and Birmingham together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh, Mill	Birmingham Mill	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2 15@2 25	$2 40	3 29	$4 40	$3.00	$3 05	$3 35
Channel, 3 to 15 in.	2 15@2.25	2 40	3 29	4 40	3.00	3 05	3 35
Angles, 3 to 6 in., ¼ in. thick	2 15@2 25	2 40	3 29	4 40	3 00	3 05	3 35
Tees, 3 in. and larger	2 15@2.25	2 40	3 29	4 40	3 00	3 05	3 35
Plates, ¼ in. thick and heavier	2.15@2.25	2 40	3 29	4 40	3.00	3.05	3 45

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York—Mar. 1	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.00	$3 85	$3 50	$3 75	$3 85	$4.75	$4 95
CONE HEAD BOILER							
½ in. and larger	$3.10	3.95	3.60	3.85	3.95	4.85	5.05
⅝ and ¾	3.25	4.11	3.76	4.00	4.10	5.00	5.20
⅞ and 1	3.50	4.35	4.00	4.25	4.35	5.25	5.45

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.80@3.00	$3.45	$4.10	$4.25	$3.14	$4.95
Cut	3.20@3.25	5.50	5.80	5.75	3.24	5.00

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.10 per roll in carload lots and $2.70 for smaller quantities f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $5.50 per square (sufficient to cover 100 sq.ft.) in carloads; $5.75 in smaller quantities, f.o.b. Philadelphia Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., $6.05.

ROOFING MATERIALS—Prices f.o.b. New York, in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$73.50
Tar pitch (in 400-lb. bbl.), per 100 lb	1.62½
Asphalt roofing (in barrels), per ton, f.o.b. plant*	37.00
Asphalt felt (light), per ton, f.o.b. plant*	67.50
Asphalt felt (heavy), per ton, f.o.b. plant*	67.50

* Delivered in Metropolitan Dist., $3.00 additional.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2 50@2.75	4.10	$4.00	$4.35	$4 19
No. 12	2.60@2.85	4.15	4 05	4 40	4 24
No. 14	2 70@2.95	4.20	4 10	4 45	4.29
No. 16	2 90@3.15	4.30	4.20	4.55	4 39
Black					
*Nos. 18 and 20	3 20@3.35	4.65	4.70	5 70	4.70
*Nos. 22 and 24	3 25@3.40	4 70	4 70	5 75	4.75
*No. 26	3 30@3.45	4.75	4 75	5 80	4.80
*No. 28	3 35@3.50	4.80	4 85	5 90	4.90
Galvanized					
No. 10	3.35@3.75	4.85	4 85	....	4.90
No. 12	3 45@3.85	4.95	4 95	5.85	5.00
No. 14	3 45@3.85	5 00	4 95	5 85	5.00
Nos. 17 to 21	3 75@4.15	5.10	....	6 15	5.30
Nos. 22 and 24	3 90@4.30	5.40	5 40	6.30	5.45
*Nos. 25 and 26	4 05@4.45	5.55	5 55	6.45	5.60
*No. 28	4.35@4.75	5.85	5.90	6.75	5.90

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Mar. 1	New York: One Year Ago	Chicago: Mar. 1	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$1.01	$0.87	$1 07	$0.91

WHITE AND RED LEAD—Base price in cents per pound:

	Red				White	
	Mar. 1		1 Year Ago		Mar. 1	Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	14 25	15 75	12 25	13 75	14 25	12 25
25 and 50-lb. kegs	14 50	16 00	12 50	14 00	14 50	12 50
12½-lb. keg	14 75	16 25	12 75	14 25	14 75	12 75
5-lb. cans	17 25	18 75	15 25	16 75	17 25	15 25
1-lb. cans	19 25	20 75	17 25	18 75	19 25	17 25

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M ft. additional.

	6–8 and 12 Ft.	10–16–18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$38 00	$39 00	$40 00	$43 00
3x6 and 8	38 00	39 00	40 00	43 00
4x4-6 and 8	38 00	39 00	40 00	43 00
3x10 and 12	38 00	39 00	40 00	43 00
3x14	40 00	40 00	42 00	44 00
4x10 and 12	38 00	39 00	40 00	43 00
4x14	40 00	40 00	42 00	44 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$40 00	$42 00	$44 00
6x14	40 00	42 00	44 00
8x10	40 00	42 00	44 00
8x14	40 00	42 00	44.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22–24 Ft.	20 Ft. and Under	22–24 Ft.
3x 4 to 8x8	$51 00	$52 00	$54 50	$56 50
3x10 to 10x10	54 00	55 00	57 50	59 50
3x12 to 12x12	58 00	59 00	60 50	62 50
3x14 to 14x14	64 00	65 00	65 50	67 50
3x16 to 16x16	71 00	72 00	70 50	72 50
3x18 to 18x18	84 00	85 00	82 50	83 50
4x20 to 20x20	94.00	95 00	93.50	95.50

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine up to 14 x 14 costs $15 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20 Ft. and Under				12 x 12-In. 20 Ft. and Under	
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston	$67 00	$125.00	$65.00	$65 00	$90 00	$140.00
Seattle	.....	28.00	.....	.....	.....	29 00
New Orleans	40 00	.....	.....	35.00	45 00	.....
Baltimore	35.00	53.00	53 00	60.00	50.00	53.00
Cincinnati	45 00	51.50	51.50	51.50	*45.00*	53.50
Montreal	50.00	50.00	40.00	38.00	95 00	90.00
Los Angeles	.....	.....	.....	.....	.....	.....
Denver	.....	41.00	44.00	41.00	.....	51.00
Minneapolis	46 50	43.75	41.00	.....	49 00	44.75
Atlanta	33 00	.....	.....	.....	37 00	.....
Dallas	48 00	.....	.....	.....	53 00	.....
Kansas City	43 75	.....	.....	.....	56 75	.....
Birmingham	32.00	.....	.....	.....	40.00	.....
Philadelphia	45.00	40.00	40.00	44.00	56 00	40 00
Detroit	46.75	48.25	.....	.....	55.75	48.25
St. Louis	*44.00*	.....	.....	.....	51 00	.....

	1-In. Rough, 10 In. x 16 Ft.—and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir	Hemlock	P.	Fir
Boston	$50.00	$85.00	$50.00	$60 00	$100.00
Seattle	.....	24.00	.....	.....	26.00
New Orleans, at mill	85 00	.....	.....	39.00	.....
Baltimore	65.00	44 00	44 00	37.00	55.00
Cincinnati	*60.00*	82 00	82 00	35.00	*78.00*
Montreal	60.00	50.00	37.00	45.00	45.00
Los Angeles	.....	.....	.....	.....	.....
Denver	.....	37.25	37.25	.....	36.25
Minneapolis	48.50	42.50	38.50	43.75	41.25
Atlanta	17.00	.....	.....	27.00	.....
Dallas	48 00	36.00	.....	51.50	.....
Kansas City	78 00	60.00	.....	*44.20*	47.50
Birmingham	28.00	.....	.....	32.00	.....
Philadelphia	35.00	41.50	40.00	55.00	40.00
Detroit	48.00	40.00	.....	46.50	41.50
St. Louis	*45.50*	.....	.....	*35.50*	.....

Birmingham—Quotes carload lots, f.o.b. sidings. $1.50 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers prices to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M. ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M. ft. additional.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.315	Detroit	$0.295
Birmingham	.69	Kansas City	.735
Boston	.365	New Orleans	.515
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.50†
Cincinnati	.295	Philadelphia	.325
Cleveland	.215	St. Louis	.43
Denver	1.275*	St. Paul	.595

* Minimum carload, 40,000 lb.

†Minimum carload, 50,000 lb., structural steel only; 80,000, lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f. o. b. Pittsburgh, with a comparison of a month and a year ago:

Mar. 1	One Month Ago	One Year Ago
$2.15@2.30	$2@2.05	$1.80

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	25%
Patent flattened strand, special and cast steel	25%
Patent flattened strand, iron rope	10%
Plow steel round strand rope	40%
Special steel round strand rope	35%
Cast steel round strand rope	27½%
Round strand iron and iron tiller	10%
Galvanized steel rigging and guy rope	12½%
Galvanized iron rigging and guy rope	+7½%

California, Oregon, Nevada and Washington Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ¼ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft., ½-in., 6; ⅜-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.16½	New Orleans	$0 18½
New York	18	Los Angeles	.....
Chicago	18	Seattle	18
Minneapolis	20½	St. Louis	20½
San Francisco	16	Montreal	30
Atlanta	18½	Detroit	19
Denver	22	Baltimore	18
Cincinnati	20	Kansas City	21
Dallas	129	Birmingham	20½
Philadelphia	18		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.36
Boston	.23	.25
Kansas City	.2225	.2525
Seattle	.165	.195
Chicago	.22	.25
Minneapolis	.189	.2094
St. Louis	.2225	.2525
Denver	.2025	.2325
Dallas	.29	.375
Los Angeles	.....	.....
Atlanta	.23	.26
Baltimore	.215	.225
Cincinnati	.22	.25
Montreal	.195	.235
Birmingham, *delivered*	.20	.22
New Orleans	.235	.265
San Francisco	.1625	.1925
Philadelphia	.25	.28

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.13	$0.17½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	0.17½	0.22
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	0.19½	0.24
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	0.23	0.32
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	0.25	0.34
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	0.32	0.38

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$17 00	$11.50	$16.00
Stove plate	16 00	12.00	16.50
No. 1 machinery cast	20 00	16.50	20.00
Machine shop turnings	13 00	4.00	10 00
Cast borings	14 00	5.50	11.00
Railroad malleable cast	19 00	12.50	18.50
Re-rolling rails	19 00	13.00	20.00
Relaying rails	28.50	30.00	28@32
Heavy melting steel	17.50	.....	.....

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$8.25	$6.25	$8.00
⅝	7.30	5.80	7.75
¾	7.15	5.65	7.70

Pittsburgh base in lots of 200 kegs or more, $3.50.

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